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The Cost of Maintenance Haemodialysis: Implications for Dialysis Planning

by

Steven D. Soroka ©

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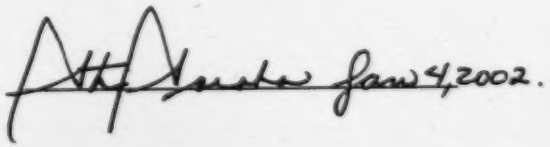

Steven D. Soroka

Room 5088, Dickson Building
QE II Health Sciences Complex
5820 University Avenue
Halifax, NS B3H 1V9

University of Alberta

Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled The Cost of Maintenance Haemodialysis: Implications for Dialysis Planning submitted by Steven D. Soroka in partial fulfilment of the requirements for the degree of Master of Science in Medical Sciences – Public Health Sciences.

Dr. P. Jacobs

Dr. L.D. Saunders

Dr. B.A. Kiberd

Dec 19, 2001

Dr. A. Ohinmaa

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Chapter 1

1.1 Introduction

Dialysis is a high-cost low-volume service necessary for maintaining life in individuals with end-stage renal disease (ESRD). Medicare spending for ESRD was 12.04 billion dollars in the US in 1998, and is predicted to exceed 28 billion dollars by 2010 [1;2] . Although renal transplantation is the preferred method of renal replacement therapy (RRT), many individuals with renal failure will never receive a transplant. Decreasing numbers of cadaver organs and co-morbid medical conditions including age preclude many individuals from transplantation [2]

All renal programs in Canada are facing a crisis in providing adequate care to increasing numbers of individuals with renal failure. Canadian Organ Replacement Register (CORR) data from 1998 revealed that 12,808 Canadians were receiving dialysis therapy [3] . The prevalence rate was 422 per million population (pmp), an increase from 275 pmp in 1992 [3] . USA prevalence rates were 479 pmp in 1992 and 828 pmp in 1998 [2] . There were 4025 new Canadian dialysis patients in 1998 [3] . The most common causes of renal failure were hypertension, cardiovascular disease and diabetes.

The annual growth rate in Canadian haemodialysis programs has ranged from 9.6 to 20.5% over the last 5 years [3] . The largest growth has been in the over 65-year-old age group as well as the 45 – 65 year-old diabetic group. A decrease in

mortality rates in dialysis patients has also been noted from 1981 to 1997[1] . Therefore, the combination of increased incidence rates, decreased transplantation in certain groups and decreased mortality has and will result in continued expansion of the dialysis population.

Haemodialysis is becoming the most common modality of renal replacement therapy, especially for the elderly patients with other medical co-morbidities [4] . Many of these patients are referred for nephrology care late and therefore start and remain on haemodialysis. There was a 9.9 % increase in the number of haemodialysis patients from 1997 to 1998; haemodialysis was the modality of treatment for 73 % of all dialysis patients [3] .

Treatment of kidney disease includes pre-end stage renal care and end stage renal care. Renal replacement therapy options for end stage renal disease include renal transplantation, peritoneal dialysis and haemodialysis. The initial modality of treatment depends not only on patient characteristics, but on how far in advance patients are referred for pre end-stage renal care. In 1998, 77 % of incident patients started dialysis on haemodialysis [3] .

Haemodialysis is also the most costly method of renal replacement therapy. Many studies done in North America and Europe have shown that Transplantation and Peritoneal dialysis are less expensive methods of treating renal failure [4-10] . Studies have also shown that provision of haemodialysis in a tertiary care centre is more expensive than in a peripheral or satellite dialysis unit (either free-standing or in a local hospital) [4] . Patients receiving dialysis that live

away from major referral centres prefer dialysis in a unit close to where they live. Patients, their families and local communities continue to lobby renal programs to establish these satellite dialysis units. Most Canadian renal programs consider satellite haemodialysis to be less expensive than in-centre treatment. Some economic studies done to date suggest that satellite dialysis is less expensive than dialysis provided in tertiary care hospitals (In-centre dialysis)[11;12] .

Funding for end stage renal disease care is healthcare system specific [10]. In the USA, dialysis is reimbursed through Medicare [10;13-15] . Canada has a global budget system. Dialysis services are provided under the Canadian public health care system. Administration of health care services is a provincial jurisdiction. Within each province money flows from the Ministry of Health to renal programs as a lump sum of money assigned to renal replacement therapy, usually through the hospital budget. The total renal program budget is composed of budgets from each the components, i.e. transplantation, haemodialysis, peritoneal dialysis and pre-dialysis care. Transplantation is usually separate from dialysis and inpatient services can be separate from outpatient dialysis services, although there is some province-to-province variability. With the recent crisis in health care the final dollars given to renal programs to operate has been less than requested. Renal programs then have to provide care within the constraints of finite dollars.

Deciding on how to provide adequate haemodialysis to the growing numbers of patients with renal failure is a concern of all renal programs in Canada.

Identifying areas for cost saving requires that sufficient detail with regard to patient resource utilization and the cost of each resource used is collected.

Determining the cost of providing care to patients with renal failure is complex due to several factors. Renal failure can result from a wide number of diseases, which can be either kidney specific or part of a systemic disease. Patients with mild to moderate renal impairment can develop irreversible renal failure after surgery or other diagnostic or therapeutic medical procedures.

Therefore, the cost of providing health care to a patient with renal failure is made up of several cost components. First, there is the resource use and cost associated with treatment of all the patient's medical problems, whether or not they impact on or are associated with the renal disease. These costs accrue both before and after the start of maintenance haemodialysis. Second, is the resource use and costs associated with starting dialysis. Resource use and costs associated with starting dialysis can vary widely among patients with end stage renal disease because of differences in underlying medical conditions and timing of referral for dialysis. The final component is the cost of providing maintenance haemodialysis. Each of the components is considered in more detail below.

The cost of the initial start of dialysis is dependant on when the patient was referred for nephrology care, and if a dialysis access was created early enough that the patient starts dialysis as an outpatient [16-19] . If the patient is referred late, they may start dialysis as an outpatient through a temporary access or need to be admitted to hospital to start dialysis [20] . Some patients with dialysis access

created early still start dialysis in the hospital or even in the intensive care unit if they suffer a complication from an underlying medical condition. This can impact significantly on the total cost of starting dialysis.

Timing of referral as well as the underlying health status of the patients' impact on costs associated with the start of dialysis [16;18;19]. From a program point of view, there is usually limited ability to impact on referral patterns. Even multidisciplinary pre-dialysis clinics, which are beneficial in preparing patients for renal replacement therapy, are only of benefit to the patients who are referred in a timely fashion [21] . Any major impact on the costs of starting dialysis will come only when referring physicians and patients are educated about the importance of timely referral to renal programs.

After the patient is established on haemodialysis ongoing costs accrue in several areas. There are costs associated with maintaining vascular access and the cost of complications related to vascular access. There is increasing use of Interventional Radiologists in maintaining vascular access in the haemodialysis population [22] . This area itself requires a full costing analysis and economic evaluation, especially since this is a relatively new trend with unknown cost effectiveness.

Costs continue to accrue related to underlying medical problems and co-morbid conditions. Many medical conditions can result in renal failure. Systemic diseases such as diabetes and hypertension are the most common aetiologies of

renal failure. Other organ or body system involvement such as coronary artery disease and peripheral vascular disease is invariably present when the patient starts on dialysis. These conditions are not reversed by dialysis and contribute significantly to the cost of dialysis patient care. These costs are seen in both inpatient hospitalization cost as well as outpatient costs.

Finally, there is the cost of maintenance haemodialysis, or the cost of providing three dialysis treatments per week for 52 weeks of the year. The traditional model used to provide this care was a dialysis unit built in a hospital with other critical care services such as intensive care units. All patients starting on haemodialysis would start in these In-centre units. Home haemodialysis was a form of dialysis popular in the past. Younger, otherwise healthy patients who were motivated and had consistent help from a family member would have a machine placed in their home and be trained to perform haemodialysis on a thrice-weekly basis.

In recent years, the number of individuals on home haemodialysis has declined [3]. A replacement for this has been the satellite dialysis unit. This is a dialysis unit built away from the main In-centre unit of a hospital with a renal program. This unit could be built in another part of the tertiary care hospital complex, built in another part of the same city or built in another suburb, city or town. Satellite refers to connection with the main In-centre unit for support and management. Several issues have led to an increasing number of satellite units. One is the decreasing availability of space in tertiary care hospitals. Another is the request

of patients on dialysis to receive treatment as close to their residence as possible. Satellite dialysis units accept only medically suitable patients. The staff to patient ratio is different from In-centre units and the staffing mix varies.

As renal programs are faced with increasing numbers of haemodialysis patients to treat with budgets less than requested, providing dialysis treatments more efficiently at lower cost is critical. Early referral may lead to decrease costs of starting dialysis, especially if inpatient dialysis starts can be decreased and less expensive therapies such as peritoneal dialysis are used. Early referral and vascular access placement may decrease costs of vascular access maintenance. It does not seem possible to decrease costs associated with co-morbid conditions unless individuals with these conditions were not offered renal replacement therapy. In addition, many of the additional costs are one time, up front costs, which likely to be smaller than the ongoing treatment costs.

Ongoing treatment costs are likely to be the more important area to explore for cost savings. It therefore follows that detailed data on resource utilization and associated costs of maintenance haemodialysis is of paramount importance for future planning of dialysis facility expansion. The recent technological advances in medical treatments including treatment of renal failure have made dialysis more widely available. The reality of increasing demand for dialysis and decreasing medical budgets make issues such as resource utilization, costs and cost effects increasingly more important. Resource utilization and costing data

will be useful not only to identify potential areas of cost saving but also to explore how different models of care may impact on resource utilization.

1.2 Review of Existing Literature

An attempt was made to identify all articles published pertaining to economic evaluation of dialysis. A search strategy was developed for Medline (Appendix A). A companion strategy was developed for Embase. Abstracts from the over 200 papers identified were reviewed and the ones considered most appropriate were obtained. Bibliographies of all the papers were reviewed for further references.

Thirty-four studies were reviewed in detail. Of these fifteen were from the USA, and most of these studies used data on government reimbursement for dialysis services [4;7;13;13;23-33]. Medicare, which is the provider for most of dialysis in the USA only reimburses for about 75 % of the costs [13]. Not one of the American studies considered satellite haemodialysis. Eight European studies were reviewed which compared to the costs of In-centre, self-care and home haemodialysis [4;9;30;34-38]. Self-care haemodialysis involves the patient, who will set up the dialysis machine and place needles into their dialysis access. This requires less nursing care than a satellite unit where patients do not perform any duties. Five studies from other countries such as South America [39], Saudi Arabia [40], and New Zealand [41] were also reviewed.

Eight studies done in Canada were identified and reviewed. Two of these studies were unpublished [11;12] . One of the studies done by the British Columbia Renal Council in 1994,which has some data published in another paper [10]. The other unpublished study was done by Baxter Canada in 1992 [12], and involved data comparing In-centre haemodialysis to peritoneal dialysis. One study was the cost of haemodialysis and peritoneal dialysis in paediatric patients [42]. In the three remaining studies, two considered costs of In-centre, self-care and home haemodialysis as well as peritoneal dialysis [43;44] . The third study compared In-centre and home haemodialysis to peritoneal dialysis [45] . Another study identified collected actual resource use, but was done in 1990, and contained only the cost of In-centre haemodialysis [46] . A final Canadian study which included the cost of haemodialysis was done to determine the cost-utility of renal transplantation [47] . Considering all the Canadian studies, the most recent was the BC Renal Council [11], while the costs in the most recently published were in 1993 dollars [44].

Therefore, the current literature is not optimal for exploring the issue of cost minimization in maintenance haemodialysis, especially if a comparison to satellite haemodialysis is needed. There is difficulty in comparing studies done in other countries due to differences in health care systems and funding for haemodialysis [10] . All of the studies done in the USA are based on the Diagnosis Related Group-type reimbursement rate for dialysis [13-15;23;25;27;29;32;48] . Even when comparing countries that have global funding for dialysis such as Canada and the UK, Denmark or Finland there are differences in economic situation, cost

of living and purchasing power that make direct conversion or comparison difficult [10].

Additional problems associated with comparing studies include the following. Study methodology is not described in detail. Individual costs were not always included or aggregated costs were used. Most studies did not consider the influence of case-mix on costs. Global estimates of costs are of limited use as some components may increase more than others.

Finally, assessing cost effectiveness of different dialysis modalities is even more difficult due to a number of issues that impact on both cost and effects. These include high mortality and hospitalization rates, low rehabilitation and employment rates and changes in adjusted survival or functional status. Timing of initiation of dialysis impacts on costs in the pre-ESRD stage vs. the ESRD stage. Changes from one modality to another are also seen, such as starting on peritoneal dialysis and then switching to haemodialysis, or starting on In-centre haemodialysis and changing to satellite haemodialysis. Patients underlying health or situation often dictates which modality is most appropriate at that time. Some therapies, such as CAPD require more individual or family effort. Health and social situations can change in either a negative of positive way impacting on cost and effectiveness of modality. No randomized controlled trials assessing different dialysis modalities have been done [49].

In the end, the most practical approach to take to deal with the increasing demand for dialysis is to examine the costs of the most expensive components

that would be most amenable to change in all consumers. In dialysis this is the cost of maintenance treatment.

1.3 Study Hypothesis, Perspective and Objectives

1.3.1 Study Hypothesis

Maintenance Satellite haemodialysis is less costly compared with In-centre haemodialysis.

1.3.2 Study Perspective

As the purpose of the study was to collect information useful for provincial dialysis planning, the perspective of the health care institution, QE II Health Sciences Centre, and service provider, Nova Scotia Ministry of Health, were taken as the primary perspectives, rather than societal [50].

1.3.3 General Objective

To conduct a cost analysis from the perspective of the health institution and service provider of satellite and In-centre haemodialysis, taking into account patient suitability for satellite dialysis.

Specific Objectives

- To compare In-centre and satellite dialysis in terms of resource utilization and costs of providing maintenance haemodialysis.
- To identify resource or cost components that may be amenable to modification for cost reduction.

- To use the results to plan a cost minimizing strategy for expansion of dialysis in Nova Scotia.

Justification of Perspective

The health institution and service provider perspective were chosen as the primary perspectives as the Renal Program at the QE II HSC is responsible for planning of haemodialysis services in the province of Nova Scotia while funding is from the Provincial Ministry of Health [50;51].

1.4 Study Setting

The population of Nova Scotia was 941,000 in 2000, while the population of PEI was 138,900[52]. In Nova Scotia 18.2 % of the population is age 14 or less, 68.6 % between the ages of 15 to 64, and 13.2 % over the age of 65. Male to female ratios are roughly the same, except in the over 65-age group where women account for 58 % of this age group [52].

The majority of dialysis in Nova Scotia is delivered via a single program with administration in Halifax, Nova Scotia. Two smaller regional programs exist in Sydney, Cape Breton and Yarmouth, Nova Scotia. Individuals requiring dialysis have various options depending on their general medical condition and geographic location. The bulk of haemodialysis is provided by an in centre dialysis unit located in a tertiary care hospital in Halifax. A satellite unit is also available in the same hospital for medically stable patients. Other satellite units are available in Nova Scotia and PEI for medically stable patients established on haemodialysis.

A dialyser reuse program was started for the In-centre unit in 1998. All patients receiving maintenance haemodialysis in the In-centre units are given treatment with high flux, high efficiency dialysers that are, on average, reused ten times. The reuse process is heat-citrate sterilization, which is the industry standard for the type of dialyser used. Patients in the satellite units receive treatment with single use low flux, high efficiency dialyser. All other components of the dialysis treatments are similar.

Satellite units are built and maintained in small cities and towns in response to patients' requests to receive dialysis closer to home. Currently there are eight satellite haemodialysis units in Nova Scotia accommodating between one and eleven patients. Individuals must meet specific criteria in order to receive haemodialysis in these units (Appendix B). These criteria were determined by the medical team (physician and nursing) and include the presence of a well functioning arteriovenous access and the absence of any severe or unstable cardiac or pulmonary disease. The reason for the eligibility criteria for the satellite units is that the units are staffed by Dialysis Assistants, whom do not have the same degree of medical training as Registered nurses. All patients are assigned to the dialysis clinic nearest their residence.

As of December 2000, the Nova Scotia Renal Program included 198 In-centre haemodialysis patients and 42 satellite haemodialysis patients. An additional 21 satellite haemodialysis patients in PEI also received some nursing and physician support from the renal program.

Planning delivery of haemodialysis for the future continues to be of paramount importance, as the provincial haemodialysis projections for December 2001 estimate 253 In-centre patients and 49 satellite haemodialysis patients [53-55] . The In-centre haemodialysis capacity is 222 patients, a projected shortfall of 31 patient treatment spots.

Planning expansion of dialysis facilities within a regional health authority involves not only the reality of decreasing health care budgets, but also more programs competing for less funding. Developing the least expensive model of providing optimal care requires a detailed critical appraisal of programs currently in place. This philosophy was the major impetus for embarking on this study.

Chapter 2

Methods

For the study, resource utilization and costs were compared for patients receiving total care treatment in the In-centre haemodialysis unit located in the Queen Elizabeth II Health Sciences Centre (QE II HSC) with Nova Scotia Satellite haemodialysis unit patients. All costs are in year 2000 Canadian dollars, unless otherwise specified. The methods used follow the suggested methods and guidelines put forth for economic evaluation [50;51;56-58] .The following information was collected on all study subjects.

1. Patient Demographics and Characteristics

2. Patient Resource Utilization

    2.1 Medical Staff
        2.1.1 Physician

    2.2 Nursing
        2.2.1 Nursing Administration
        2.2.2 Nursing: Registered Nurse or Dialysis Assistant
        2.2.3 Unit Clerk, Unit Aide and other support staff

    2.3 Dietitian

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    2.5 Capital Costs and Consumables
        2.5.1 Supplies, Dialysis Machines and Water treatment
        2.5.2 Laboratory Tests and Medications
        2.5.3 Linen

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2.1 Patient Demographics and Characteristics

For all study subjects, patient characteristics and demographics were determined either through review of the patients' haemodialysis chart or by asking the patient. All the demographic and patient characteristic data was entered into a Microsoft Access database.

Demographics that were collected for each patient were age, gender and ethnic origin. Patient characteristics collected were Aetiology of renal failure (diabetes, hypertension, polycystic kidney disease, glomerulonephritis, other or unknown), number of months on haemodialysis, and dialysis access {arterio-venous fistula (AVF), arteriovenous graft (AVG) or central venous catheter CVC)}. The presence or absence of various co-morbidities (hypertension, diabetes, cardiovascular disease, stroke, peripheral vascular disease and amputation) was determined from review of the patients' haemodialysis chart.

The investigator, using the satellite unit criteria in Appendix B, classified in-centre patients as satellite candidates, not satellite candidates due to medical problems or not satellite candidates due to vascular access problems.

Both In-Centre and Satellite patients were asked how they travelled to dialysis (self, family, Access-A-Bus or other). Satellite patients were asked what the distance of round trip to Halifax would be in kilometres. This was used to determine the potential travel costs satellite patients that might incur if they were

required to travel for haemodialysis treatment in Halifax, rather than their satellite unit.

2.1.1 Satellite Haemodialysis Patients

The number of patients receiving haemodialysis treatment in a Nova Scotia satellite unit was determined. Individual patient data was collected on all satellite haemodialysis patients who had been receiving haemodialysis for at least 3 months at the time of data collecting in November 2000.

The rationale for choosing three months was to minimize the effect of variation in referral of patients to dialysis and the impact of this on placement of vascular access. The assumption was made that after three months there would be less difference in resource utilization as a result of early or late referral for haemodialysis. A study of the effects of early and late referral has shown that beyond the third month patient outcomes were similar [59].

The Home Dialysis Unit provides services to patients on peritoneal dialysis and satellite haemodialysis. Services provided include patient and staff training, nursing and nephrologist support for day to day medical and social problems as well as routine and as needed outpatient clinic visits. Dietitian and Social Work services are available on an as needed basis.

The Satellite haemodialysis program grew out of the home dialysis helper program, which provided nursing support to patients on home haemodialysis.

Satellite unit locations were chosen based on the presence of a group of suitable patients in a particular area of the province. All units are more than 90 kilometres or 90 minutes from the main in centre haemodialysis unit in Halifax. All satellite units were developed within existing spaces and construction costs for modification were kept to the absolute minimum required to develop the space to the standards necessary of a dialysis facility.

In order to determine if it would be possible to collect individual patient data on all patients for all resource variables, the location, unit size, and number of dialysis patients at each of the satellite units was collected. If a wide variation in the size of the Satellite units were found, a representative unit would be chosen in order to collect resource utilization of dialysis machines and water treatment.

2.1.2 In-centre Dialysis Patients

Many In-centre patients would not meet the criteria for acceptance to a satellite haemodialysis unit. In order to compare the satellite dialysis unit patients with In-centre patients who would qualify to be satellite unit patients the following was done. A dialysis worksheet is kept in the main In-centre dialysis unit, which records the names of patients receiving treatment each shift for each day of the week. Early in 2000, a list of all the In-centre patients was generated with name, gender, age, months on haemodialysis and dialysis access. An unsuccessful attempt was made to match one or two In-centre patients to each satellite patient based on age, gender and kidney disease.

In September of 2000, the list of In-centre patients was updated. All In-centre patients who would have been on haemodialysis for at least 3 months at the time of data collection in November 2000 were identified. All patients receiving treatment in the In-centre satellite unit were excluded, as the care they receive is different from the total care In-centre unit. From the remaining list of patients the investigator determined, based on the satellite inclusion criteria (Appendix B), which patients might be suitable candidates for a satellite haemodialysis unit. These patients were entered into the study and patient data was abstracted from the dialysis charts, which are kept in the In-centre haemodialysis unit within the QE II HSC.

2.2 Patient Resource Utilization

2.2.1 Staff Resource Utilization

2.2.1.1 Satellite Patients Staff Resource Utilization

Staff resource utilization data was collected on all eligible satellite dialysis patients. Table 1 shows the resource category, the way the resource use was measured, and the source of cost data. The patient number is shown because different numbers of Home Unit dialysis patients use specific resources. In order to determine a cost per patient, the appropriate number of patients must be used in the denominator.

Table 1. Satellite Haemodialysis Staff Resources

Resource Category	Measurement	Patient Number	Cost Source
Staff			
Nephrologist	Individual patient	N/A *	Provincial Benefits schedule
Dietician	Individual patient	N/A *	Hourly wage
Social Worker	Individual patient	N/A *	Hourly wage
Nursing Manager	Estimation of time spent on Nova Scotia satellite program	42	Hourly wage
Administrative Secretary	Average per patient	201	Annual salary
Home Unit Support			
Charge nurse	Individual patient	N/A *	Hourly wage
On Call Nurse	Average per patient	201	2000 Budget
HD Nurse	Average per patient	42	Hourly wage
Clinic Nurse	Individual patient	N/A *	Hourly wage
Unit Clerk	Average	201	Hourly wage
Sick Relief	Average per patient for Berwick unit	10	2000 Budget
Satellite Staff			
Dialysis Assistant	Individual per patient	N/A *	Hourly wage

* N/A means not applicable as individual patient data collected.

2.2.1.1.1 Physician Costs

Physician costs could only be determined based on Provincial fee schedule payments that were in place prior to a 1999 Alternative-funding plan. A log of time spent on individual patients was also collected by the physician in the Home Dialysis Unit for each of the two-week collection data collection periods in November 2000 and December 2000. The total time spent for the two two-week periods was added and then multiplied to estimate a total time per year.

Satellite Haemodialysis Nursing Costs

Nurses in the Home dialysis unit provide care to both peritoneal and satellite haemodialysis patients in both Nova Scotia and PEI. This may be direct patient care, such as clinic visits when the patient is seen in Halifax. It may also be indirect, via telephone, with a nurse communicating directly to a patient or through the Dialysis Assistant. In addition to this, Dialysis Assistants provide direct nursing care to the patients in the satellite dialysis unit.

Table 2. Satellite Haemodialysis Nursing Costs

Category	Duties	Location
Nursing Manager	Coordinate staffing both in Home unit and in satellite units	Halifax, travels to satellite units
Charge Nurse	Coordinates care of all satellite patients	Halifax
On Call Nurse	On call support evenings and weekends	Halifax
Haemodialysis Nurse	Spends 3 hours a week assisting the nurse manager in coordinating care of satellite HD patients	Halifax
Clinic Nurse	Reviews patients in outpatient clinic	Halifax
Illness and vacation relief	Home unit nurse travels to satellite	Satellite
Dialysis Assistant	Provides dialysis treatment patient care	Satellite

The nursing system, as shown in table 2 is present in the satellite haemodialysis program to provide care for the patients. The Nursing Manager functions as an administrator with no patient care duties. The Home Dialysis unit in Halifax provides nursing support for both Dialysis Assistants and Satellite Haemodialysis patients.

On occasion, the Home Unit nurses travel to the satellite units to provide sick relief for the Dialysis Assistants. The Dialysis Assistants provide direct care to the patients during the haemodialysis treatments.

Resource use and subsequent cost of nursing staff for satellite haemodialysis had to be determined by methods other than the financial records of the hospital which did not separate out costs for satellite haemodialysis staff from those of peritoneal dialysis staff. For some resource items, individual patient data could be collected, while for others averages based on the total number of patients using that resource were determined.

2.2.1.1.2 Satellite Haemodialysis- Administrative Staff

One Nurse manager is responsible for the Home Dialysis program and the Outpatient renal transplant and general nephrology clinic. Duties involved in the satellite haemodialysis program include budget, staffing, and planning units. Part of the job includes travel to the satellite units. The Nurse Manager of the Home Dialysis Unit estimated the average time per month spent on the Nova Scotia Satellite haemodialysis program. The total number of hours per year was estimated and a cost obtained using the Nursing Manager salary scale. The total yearly cost was divided by the number of patients to achieve a yearly cost per patient per year for Nurse Manager resources.

A half time administrative secretary is assigned to the Home Dialysis unit. Half the annual salary of the secretary was divided by the total number of Home Unit patients to obtain a cost per patient per year for administrative secretary support.

2.2.1.1.3 Satellite Haemodialysis-Charge Nurse

A Charge nurse equivalent is present in the Home Dialysis unit from 0730 to 1530 each day. There is also a nurse on call weekdays from 1530 to 0730 and weekends from 1530 on Friday night to 0730 Monday morning. The duties of the charge nurse are to provide telephone assistance to all peritoneal and satellite haemodialysis patients, as well as Dialysis assistants in the satellite haemodialysis units and other health care professionals such as nurses or physicians in local hospital emergencies or clinics. The charge nurse will communicate and discuss patient issues with the attending nephrologist or renal trainee in the dialysis unit and then contact the appropriate party (patient, Dialysis Assistant, etc) to convey changes in patient treatment.

In order to collect data only on Nova Scotia satellite haemodialysis patients a log sheet was created (Appendix C). The Charge nurse was instructed to log each new phone call or patient related activity by individual patient and to record the number of total minutes spent for each call. The total minutes were to include time spent on the phone, time spent in consultation with other renal care team members and time spent in documentation. Data collection days were Nov 6 - 19,2000 and Dec 4 –17, 2000. At the end of the data collection periods, the total amount of charge nurse time was compiled for each patient for each 2-week

period and converted to a yearly time per patient. The cost per patient per year was determined for each patient by the product of the hourly salary and the yearly total time in hours.

2.2.1.1.4 Satellite Haemodialysis -On-Call Nurse

In addition to the individual patient data collected, an attempt was made to assign a portion of the on-call payment to each satellite haemodialysis patient. The On-Call nurse provides support for all patients on peritoneal or satellite haemodialysis from 1530 to 0730 on weekdays and from 1530 on Friday until 0730 on Monday. The on-call payment is complicated and involves a rate for each eight-hour period of nine dollars plus additional wages if the nurse on call is in fact called. The entire amount spent on On-Call payment was determined from the financial records for the year 2000 and divided by the total number of patients supported by the on-call nurse to determine a cost per patient per year for on-call nursing support.

Additional Nursing Care

2.2.1.1.5 Satellite Haemodialysis - Clinic Nursing

Satellite haemodialysis unit patients are seen in a clinic setting in the Home Dialysis Unit every three months for routine follow-up care. During each clinic visit the patient is reviewed by a nurse from the home dialysis unit prior to being seen by a nephrologist. Each appointment requires 30 minutes of individual

nursing care. Each Satellite haemodialysis patient was therefore assigned two hours of Clinic Nursing Care a year to account for the clinic time.

2.2.1.1.6 Satellite Haemodialysis - Nurse Coordinator

One of the Home Dialysis nurses has the role of Satellite haemodialysis coordinator. This job involves coordination of patient care in the Nova Scotia satellite haemodialysis units as well as arranging clinic visits. The Nurse responsible for this is paid 3 hours a week for these responsibilities. The product of the total hours per year and the hourly wage were divided by the number of satellite dialysis patients to obtain a cost per patient per year.

2.2.1.1.7 Satellite Haemodialysis - Sick Relief

A nurse from the Home Dialysis Unit may travel to the satellite unit to dialyse the patients in the event of illness in any of the Dialysis Assistants. A logbook is kept in the Home unit with the daily assigned duties of each of the home unit nurses. From this log book the number of days of sick relief coverage provided by the Home unit to the various Satellite Units can be determined. Each sick relief day involves 16 hours of pay to the relief nurse to cover travel time and work time.

The number of sick days in 2000 for the Berwick satellite unit was extracted from the logbook and the cost determined. The total cost was divided by the number of patients in the Berwick unit to determine a cost per patient per year. The assumption was made that sick day coverage would be similar for all units. Travel time, per diem meal allowance and hotel costs were not collected.

2.2.1.1.8 Satellite Haemodialysis - Dialysis Assistants

Nova Scotia Satellite units are staffed exclusively with Dialysis assistants and not Registered Nurses. They are responsible for the entire dialysis procedure, including machine set up, care of the dialysis patient while receiving treatment and cleaning of the machine after each treatment. The staff to patient ratio is one to one. Dialysis assistants in the satellite haemodialysis units do not work based on full or part time equivalents. They are paid for the total hours they work in a two-week period.

A Dialysis Assistant cost per treatment for each satellite patient was determined based on the length of the treatment, including set-up and cleanup time and the hourly rate, with benefits, paid. The assumption was made that the length of treatment time for each patient did not vary over the course of the year. The cost per patient per year was determined by multiplying the cost per treatment by the number of treatments in a year (3 treatments per week for 52 weeks = 156 treatments).

2.2.1.1.9 Home Dialysis - Unit Clerk

A Unit Clerk is present in the Home Dialysis Unit from Monday to Friday. Responsibilities include answering the phones, booking clinic appointments, and recording and filing blood work on individual patients. One week of the month requires the recording and filing of routine blood work that is done on all satellite haemodialysis patients each month.

To determine the resource utilization and subsequent cost per satellite patient, the total hours of ward clerk time per year and total cost for the year 2000 was determined. The total cost was divided by total number of Home unit patients to determine a cost per patient per year. The assumption was made that all Home Unit patients required the same amount of unit clerk resource

2.2.1.2 In-centre Patient Staff Resource Utilization

The staff employed by the In-centre haemodialysis program provided care not only for patients with chronic renal failure, but for also patients with acute renal failure in the QE II HSC. It was therefore necessary to determine how many dialysis treatments (called runs) were provided in 2000. Routine In-centre dialysis program statistics are kept which record the total number of dialysis treatments done per month and the number of treatments provided to patients with acute and chronic kidney failure.

The model of care for patients with chronic renal failure receiving treatment in the total care In-centre haemodialysis unit is different from that in the Satellite units. Table 3 lists the staff resources used by the In-centre haemodialysis patients. For most of the resource categories, it was easier to determine a cost per treatment, which could then be used to generate a yearly cost per patient.

Table 3. In-centre Haemodialysis Staff

Category	Measurement	Cost Source
Staff		
Physician	Individual patient	Provincial Benefits schedule
Extended Role Nurse	Individual patient and average	Hourly salary
Nursing Manager	Average per patient	2000 Payroll Report
Administrative Secretary	Average per patient	2000 Payroll Report
HD Registered Nurse	Average per patient	2000 Payroll Report
Licensed Practical Nurse	Average per patient	2000 Payroll Report
Renal Assistant	Average per patient	2000 Payroll Report
Ward Aide	Average per patient	2000 Payroll Report
Unit Clerk	Average per patient	2000 Payroll Report

2.2.1.2.1 Physician Costs

Physician costs in the In-centre unit are not only Nephrologist costs, but also those of the Extended Role Nurse, whom are physician assistants.

2.2.1.2.1.1.Nephrologist Cost

Physician costs could only be determined based on Provincial fee schedule payments that were in place prior to the Alternative-funding plan. Individual patient data was collected by all Nephrologists and Renal Trainees for the times each was responsible for, and made rounds in, the dialysis unit during the two-week collection periods in November 2000 and December 2000. The total time

spent for the two two-week periods was added and then multiplied to estimate a total time per year.

2.2.1.2.1.2 Extended Role Nurses

In 2000, two extended role nurses (ERN) were working within the renal program. Each month, one of these nurses was assigned to the In-centre dialysis unit. The role of the ERN in the haemodialysis unit is to assist the physician assigned to the unit in the care of the patients. The ERN is responsible for reviewing all total care haemodialysis patients and making changes in dialysis related treatments either on their own using care maps or after discussion with the attending physician.

To determine patient use of ERN resource, two methods were used. For each of the data collection periods the ERN working in the dialysis unit would record the total time spent per dialysis shift and the number of patients seen. If more than 10 minutes was spent on an individual patient this was recorded separately. Time was then assigned to individual patients based on the treatment schedule. A specific cost per patient per year for ERN resource was calculated using the hourly salary. The second method used was to determine the total number of ERN hours spent in the haemodialysis unit in 2000 and the total number of patients seen in a year. The annual salary was determined and an equal time and cost assigned to each patient.

In-centre Dialysis Staff

In order to calculate actual costs of staff for In-centre haemodialysis for the year 2000, payroll items were taken from the QE II HSC financial office payroll report. The payroll reports includes all monies paid to staff, including overtime, call-backs, illness, vacation, unit premiums and benefits. Total funds were extracted for each staff category, although data available from January 2, 2000 to March 25, 2000 was provided in a different format due to a change in reporting that started with the fiscal year of April 2000 to March 2001.

To obtain a cost per patient per year for dialysis staff, the following was done. The total salary and benefits for the year 2000 were taken from the payroll reports for each dialysis staff category and a total obtained. The total cost was divided by the total number of dialysis treatments in the In-centre unit to obtain a cost per treatment.

The staff composition and mix are different in the In-centre and Satellite unit. Therefore, it was important to break the total cost into staff categories for comparison and sensitivity analysis.

Hourly salary scales were obtained for all staff categories from the financial offices of the QE II HSC (Appendix D). Benefits of 18% were added to hourly wages as per current contracts. Actual hours worked was also determined for various staff categories. This was done in order to do sensitivity analysis and explore changes in staff mix.

2.2.1.2.2 In-centre Haemodialysis Staff - Administration

2.2.1.2.2.1 Nurse Manager

From January to April 2000, one nurse manager had in her job portfolio the entire In-centre dialysis unit, including the dialyser reuse program, which was started in May 1998. The In-patient ward was added as an additional responsibility in May 2000. The Nurse Manager estimated the number of hours per week required to administer all aspects of the In-centre dialysis program. Using the actual salary paid, a total cost per year was calculated, and then divided by the number of dialysis treatments in the year to obtain a cost per treatment.

2.2.1.2.2.2 Administrative Secretary

A half time administrative secretary is assigned to the In-centre haemodialysis program, working 18.75 hours per week. The product of total hours worked per year and salary was divided by the total number of In-centre haemodialysis patients in order to calculate a cost per patient per year.

2.2.1.2.2.3 Unit Clerk

Unit clerks are present in the In-centre unit to provide clerical and receptionist duties. The yearly cost was divided by the total treatments in the year to obtain a cost per treatment.

2.2.1.2.3 In-centre Haemodialysis Staff - Nursing

2.2.1.2.3.1 Registered Nursing

Registered nursing staff in the In-centre unit consists of a charge nurse and haemodialysis nurses. The charge nurse coordinates patient care on a shift-to-shift basis in the haemodialysis unit and is responsible for patient and nursing scheduling. The haemodialysis nurse provides the majority of direct patient care during each treatment.

Other studies have shown that registered nursing costs were a major portion of In-centre dialysis costs [10;14;26;35;37;42] . In order to explore variation in staff mix, individual patient data on nursing resource requirements was collected. This was done on an individual patient basis-using GRASP, an instrument designed to collect nursing workload measure [60;61] . This instrument is used several times a year in the In-centre unit in order to determine nursing workload.

A scanner form is used to collect the data on individual patients under categories of nursing care which include initial dialysis assessment, patient teaching, patient monitoring, simple dressings, blood collection and administering subcutaneous or intravenous medications. Grasp captures total time for the dialysis treatment. After the scanner form is completed, the data is compiled and analyzed to plan staff intensity adjustments or to validate and justify staffing adjustments that have been made.

During the dates of December 4 – 9,2000 and December 11 – 16,2000 the GRASP data was obtained for all patients dialyzing in the In-centre haemodialysis unit. For individual patients total nursing time per dialysis treatment was collected for 5 to 6 treatments. Nursing resource time was determined by averaging all the available individual GRASP times.

2.2.1.2.3.2 Renal Assistant

The renal assistant helps the RN in the care of the patient: prepares the dialysis machine for new patients and cleans after patients. The Renal Assistant may also porter patients to and from the dialysis unit, as well as maintaining inventory control and stocking of dialysis supplies.

Four renal assistants work during the course of a day, helping to care for the patients. The assumption was made that each patient required the same amount of renal assistant time. For the dates of December 4 – 9,2000, the number of renal assistant hours was determined as well as the number of patients to determine a portion of time per patient. In addition to the actual time, the ideal time was determined based on the ideal hours of renal assistant time and the average number of patients.

2.2.1.2.3.3 Unit Aide

This job involves transport of patients, helping patients obtain weights before and after dialysis. The total hours worked was determined from the payroll sheets, and the number of patients receiving treatment from the patient schedule.

2.2.1.3 Patient Resource Utilization- Dietitian and Social Worker

The amount of Dietitian and Social Worker resource utilization was determined for the In-centre and Satellite haemodialysis patients

2.2.1.3.1 Dietitian Cost

For individual dietician resource utilization, data was taken from the Nutrition Flow sheet in the dialysis chart of each patient. Starting in July 2000, the renal dietician recorded the total minutes spent with each patient at each encounter on the Nutrition flow sheet. The total minutes for July to December 2000 was determined and multiplied by 2 to approximate a yearly time in hours, then multiplied by the hourly salary to obtain a yearly cost.

2.2.1.3.2 Social Work Cost

Renal Social Workers record activity for each individual patient and their families on log sheets. The data is entered into a Microsoft Access database, which is maintained by the Department of social work at the QE II HSC. In order to obtain individual patient social work resource utilization for the year 2000 a list of all the patients' hospital unit numbers was provided in order to create a query to obtain data from the database. The total number of minutes per patient for the year 2000 was obtained and converted to hours. Using the salary scales obtained from the hospital a cost per patient for the year 2000 was calculated for Social Work resource utilization.

2.2.2 Patient Resource Utilization - Supplies and Machines

The second category of resource utilization for both the In-centre and satellite patients was supplies and machines. Table 4 below lists the resource category, how the measurement was made and the source of costs. Resource categories are the same for both the In-centre and Satellite units.

Table 4. Haemodialysis Supply and Machine Costs

Resource Category	Measurement	Cost Source
Dialysis supplies	Average cost per treatment	Supply contracts
Dialysis Machines	Average cost per treatment	Technical budget
Water Treatment	Average cost per treatment	Technical budget

2.2.2.1 Haemodialysis Supplies

Making a list and counting all the items needed to provide a haemodialysis treatment session identified supplies needed for each dialysis treatment. Prices for each supply item were obtained from the dialysis unit budget. The prices listed are charges as per contracts with various suppliers, rather than absolute costs.

2.2.2.2 Haemodialysis Machine Cost

A dialysis machine is required to provide haemodialysis. The total cost of each machine includes the capital cost of the machine plus the cost of maintenance, which consists of parts and labour.

2.2.2.2.1 Haemodialysis Machine - Capital Cost

The initial capital cost of a dialysis machine was obtained form the records of the Chief dialysis technician. The useful lifespan of the machine and value at the end of the lifespan were determined by discussion with the Chief technician. A Microsoft Excel spreadsheet was used to calculate the annual cost of a dialysis machine assuming a constant rate of machine depreciation. The Method used [58;62] results in similar estimates as the method proposed by Drummond (Appendix E) [57].

2.2.2.2.2 Haemodialysis Machine - Maintenance and Repair Cost

Cost of machine maintenance and repair is a composite of three components:

1. Salary for the dialysis technician
2. Parts for the machine
3. Travel costs when servicing machines in the satellite unit.

The salary for the technician was obtained from the records kept by the chief technician and the salary scales from the financial office of QE II HSC. Information on the cost of parts for the machines and travel costs for the dialysis technicians was obtained form the records of the Chief technician. Travel and part costs were obtained for the In-centre unit and for the Berwick satellite unit.

All of the cost components were added together to calculate a total yearly cost for dialysis machines for the two units. The total cost of each unit was divided by

the total number of dialysis treatments in each unit to determine a cost per treatment.

2.2.2.3 Haemodialysis Water Treatment

Water treatment is another important component of haemodialysis treatment as it must have a specific ion and mineral content and be free of bacteria or bacterial products. Modifying the mineral and ion content of tap water by either a deionising or reverse osmosis process produces dialysis water. Bacterial content is controlled by filters and ensuring that the pathway of water transit from the deioniser or reverse osmosis system to the dialysis machines is flushed to prevent stagnant areas where bacteria could multiply. Water quality for haemodialysis must conform to national standards and quality testing must be done on a regular basis. The total cost of water treatment contains four components:

1. Capital cost of equipment
2. Parts: membranes, filters, including shipping of parts to satellite units.
3. Labour costs for maintenance, repair and cleaning.
4. Quality assurance testing and documentation.

2.2.2.3.1 Haemodialysis Water Treatment - Capital Cost

Two types of water treatment are used in the satellite units, deionising (DI) systems and reverse osmosis (RO) systems. DI systems deionise local water to make it suitable for haemodialysis. The cost of using a DI system is somewhat dependant on the local water quality. Ion tanks require regeneration when they become depleted. Reverse Osmosis is the other system used to treat water for satellite haemodialysis.

In the Berwick satellite, a DI system was used for the majority of water from January to April 2000. From April 2000, a Biopure Reverse Osmosis system was used for the bulk of water used, while the DI system was maintained as a back up system. Therefore, Capital costs for both systems were determined and a yearly cost calculated for the projected lifespan [57;58;62].

Only RO systems are used in the In-centre unit. Capital costs of the systems were obtained, and the useful lifespan estimated. Estimation of the lifespan of the treatment systems was based on discussion with the Chief technician.

2.2.2.3.2 Haemodialysis Water Treatment - Parts and Labour

Costs of parts as well as labour were taken from the records of the Chief dialysis technician. In both cases, separate costs and hours of labour were obtained for the Berwick Satellite unit and the In-centre unit.

2.2.2.3.3 Haemodialysis Water Treatment - Quality Control

Water Quality Assurance consists of mineral and trace element testing as well as bacterial and bacterial product (endotoxin) assays. The Chemical tests include a package of: Na, K, Ca, Mg, SO_4, F, NO_3, As, Pb, Cu, Zn, Ba, Cr, Ag, Cd, Se, and Al. Bacteria testing consists of plating for colony forming units (CFU's); the allowed limit is 5 CFU's per ml. Endotoxin assays are also done on feed and product water.

All water samples are sent to the main laboratory at the QE II HSC. There are a set number of samples sent on a regular basis from each unit. The cost of each test was obtained from the QE II HSC laboratory.

For both the In-centre unit and the Berwick Satellite unit the number samples of each test for the year was determined. Using the cost per test, a yearly cost was determined. This cost was divided by the number of treatments in the unit for the year to arrive at a cost per haemodialysis treatment.

2.2.3 Haemodialysis Laboratory Tests and Medications

Table 5 lists the categories of Laboratory tests and Medications for which costs were collected.

Table 5. Haemodialysis Laboratory Tests and Medications

Category	Resource Collection	Cost Source
Lab Tests	Average number of routine tests per year	NS Dept. of Health
Medications		
Heparin	Average per patient	QE II Pharmacy budget
Eprex	Individual patient	QE II Pharmacy budget
IV Iron	Individual patient	QE II Pharmacy budget

2.2.3.1 Haemodialysis Laboratory Tests

The list of the type of laboratory tests and their frequency was taken from the haemodialysis unit policy of routine blood work done on all haemodialysis patients. The laboratory tests listed are the standard obtained from all patients, usually on a monthly basis. Some tests are only done 3 to 4 times a year. The frequencies listed below do not take into account any additional blood work that may be done on an individual patient basis. Such additional blood work is done in response to other medical problems and is therefore not directly related to maintenance haemodialysis.

Costs for tests were obtained from the QEII laboratory, which uses the Nova Scotia Department of Health and Fitness Laboratory Equity System. This system

assigns a credit to each laboratory test based on time studies for manpower, capital cost and depreciation of equipment, as well as all materials and reagents needed to perform each specific test. Each credit is equal to $1.96 and the number of credits determines the cost of each test. To obtain a yearly cost per patient for laboratory tests the products of the number of each test done per year and the cost per test were added.

2.2.3.2 Haemodialysis Medications

Medications used as part of maintenance haemodialysis were considered and Erythropoeitin, IV iron and heparin were chosen as they represent the most expensive medications. Other oral medications such as phosphate binders or oral iron preparations were not included.

2.2.3.2.1 Haemodialysis Medications - Heparin

Heparin is used as an anticoagulant in several ways during the dialysis treatment. All uses are to prevent clotting of the haemodialysis system during the treatment. An amount of heparin is used to flush the dialysis bloodlines and dialyser prior to the patient being connected to the machine (called priming). A bolus of heparin (0-3000 IU) is given at the start of the treatment either directly into the venous dialysis needle (In-centre unit) or into the venous injection port of the bloodlines (satellite unit). Maintenance heparin is also infused at an hourly rate (0 – 2000 IU/hr) throughout the dialysis treatment and the infusion is stopped before the end of the treatment (time varies from patient to patient). The maintenance heparin is drawn up into a 10 or 30 ml syringe (varies according to

dialysis machine) and the remaining heparin discarded at the end of the treatment.

For the purpose of the study, the amount of heparin used was 15 ml of 1:1000 per treatment and the total amount of heparin used per year was determined. The cost of a 30 ml vial of 1:1000 heparin was obtained from the QE II Pharmacy Department, and the cost of the yearly heparin amount calculated.

2.2.3.2.2 Haemodialysis Medications - Erythropoietin (Eprex)

Individual patient data was also collected on the use of Erythropoieitin (Eprex). Eprex is given to haemodialysis patients in order to maintain haemoglobin levels between 100 to 120 g/L. The weekly dose of Eprex was taken from the patient nursing Kardex in the haemodialysis chart. The amount of Eprex used in December 2000 was used to calculate the yearly dose. Eprex is supplied by the pharmacy in 1000, 2000 and 4000 IU preloaded syringes.

For the purpose of this study, the total number of units received for the year was divided by 4000 and then multiplied by the cost of the 4000 IU pre-filled syringes that was obtained from the QE II HSC Pharmacy.

2.2.3.2.3 Haemodialysis Medications - Intravenous Iron

Many patients receiving haemodialysis also require iron supplements to maintain adequate haemoglobin levels. Most patients are initially started on oral iron

tablets, but a significant number require intravenous iron supplementation once or twice a month.

For the purpose of the study, the monthly dose of IV iron given was determined from the December dialysis records of each patient. The assumption was made that the dose of IV iron would remain constant for the year and thus a year dose of iron, in mg, was determined.

There are two IV preparations of iron used in the haemodialysis program, iron dextran and iron saccharide. Iron dextran is less expensive, but is associated with the possible side effect of anaphylactic shock with initial or subsequent infusions. Therefore, it is always administered with an initial test dose. Iron saccharide is more expensive than dextran, but does not cause reactions. The standard protocol is to use iron dextran for IV iron therapy, unless there has been a reaction to it or the product is not available.

For the purpose of the study, the cost per patient per year for iron therapy was calculated for iron dextran. As for Eprex, the assumption was made that the monthly dose did not vary over the course of the year.

2.2.2 Haemodialysis Supplies - Linen

Linen is provided for patient care for each dialysis treatment. Charges for linen are based on a per pound charge which varies according to the item. For example, sheets are charged differently than pillowcases.

The total cost for linen for the In-centre unit in 2000 was obtained from In-centre budget summaries and divided by the total number of dialysis treatments in the unit (acute, out of unit treatments not included) to determine a cost per treatment. From this a cost per treatment year was calculated.

Linen for the Berwick unit is paid for by the Valley regional hospital. A cost could not be obtained. Therefore, an assumption was made that there is no difference in linen utilization, or cost, between In-centre and Satellite patients.

2.2.3 Haemodialysis Overhead Costs

Costs per patient per year were determined for Utilities, Housekeeping, and Administration as shown in table 6.

Table 6. Haemodialysis Overhead Costs

Overhead Resource Category	Measurement	Cost Source
Utilities	Average cost per patient	QE II HSC actual 2000 cost *
Housekeeping	Average cost per patient	QE II HSC actual 2000 cost *
Administration	Average cost per patient	QE II HSC actual 2000 cost *

* Data obtained from financial offices of the QE II HSC.

2.2.5.1 Haemodialysis - Utilities and 2.2.5.2 Haemodialysis - Housekeeping

The cost of utilities and housekeeping are based on the area a program occupies in the building [58] . Floor plans and room square footage for the dialysis areas was obtained from QE II HSC Engineering services. Square footage of the Satellite unit in Berwick was also obtained from the Western Kings Memorial Health Society, which owns and maintains the building where the Berwick Satellite Unit is located.

Space at the QE II HSC was assigned to In-centre haemodialysis, Home Dialysis, shared space between In-centre haemodialysis and Home Unit and technical space.

The cost of utilities per square foot was obtained from the Physical Plant Records of the QE II HSC. The cost per square foot for housekeeping was obtained from the Manager of Housekeeping and Contracts at the QE II HSC.

After the total square footage was determined and the annual cost was calculated, the number of patients using the space was determined and the total annual cost per patient for each space was determined.

For the Berwick Satellite Unit total operating costs were obtained, but included accounting/administration, maintenance, office operation, and utilities. An attempt to obtain any further degree of detail was unsuccessful. It was decided that the costs obtained from the QE II HSC would be used for the Berwick Satellite.

2.2.5.3 Haemodialysis - Accounting Administration

In order to assign a cost of accounting and administration to each patient, the following was done. The portion of the entire QE II HSC budget that the haemodialysis budget accounted for was determined. This portion was assumed be the same portion of the accounting/finance budget. This proportion of the Accounting/finance budget was calculated and divided by the total number of patients to determine a cost per patient per year.

2.2.6 Haemodialysis Patient Travel and Satellite Patient Travel Costs

2.2.6.1 Haemodialysis Patient Travel

All Satellite and In-centre patients were asked how they travelled to their haemodialysis treatments. They were asked to choose from one of the following options:

1. Self – the patient drove to treatments by themselves
2. Family – a family member drove the patient to and from the treatments
3. Access-a-bus- the patient used a special bus, available from city public transport for patients.
4. Other- patient travelled to treatment by another means, usually by private driver.

2.2.6.2 Satellite Patient Travel Costs

Travel costs were collected for the Satellite dialysis patients. Each satellite Haemodialysis patient was asked what the distance in kilometres would be for a round trip from their residence to Halifax. The cost of a round trip was determined by the product of the number of kilometres and the current QE II HSC reimbursement rate of $0.315 per kilometre.

2.2.7 Data Analysis

2.2.7.1. Analysis of Patient Characteristics and Demographics

For each patient group, frequencies were done for the categorical variables of gender, race, aetiology of renal failure, mode of travel to dialysis as well as the co morbidities of hypertension, cardiovascular disease, stroke, diabetes, peripheral vascular disease and amputation. Descriptive statistics were done for the continuous variables of age, months on haemodialysis, distance of satellite unit patients from Halifax, cost of transportation for satellite patients, physician, nursing, dietitian and social work time, as well as IV iron and erythropoetin cost.

To compare Satellite to In-centre patients with AVFs, Cross tabulations were done for the following categorical variables: race, aetiology of renal failure, mode of transportation, hypertension, cardiovascular disease, diabetes, stroke, peripheral vascular disease and amputation.

For continuous variables, Mann-Whitney testing was done to compare the two groups with regards to age, duration of dialysis, physician time, nursing time, social work and dietitian time as well as IV iron and erythropoetin. SPSS 10.1 for Windows Statistical Software was used for data analysis. Results are reported as mean values accompanied by standard deviation and ranges if appropriate [63].

2.2.7.2. Analysis of Resource Cost Data

The cost of each resource item was determined and converted to a cost per patient per treatment year. A treatment year was defined as 156 treatments. For

data collected on individual patients, the mean cost per patient was used to determine the yearly cost. Once the yearly cost was determined for each resource item, a total cost per patient per year was determined for the Satellite patient and the In-centre patient. The total cost consisted of the following cost categories:

1. Staff, which included all medical, nursing and support staff.
2. Capital Costs and Consumables, which consisted of supplies and machines, laboratory tests, medications and linen.
3. Overhead Costs.

The percentage that each cost category, excluding travel costs, contributed to the total cost was determined. Specific costs items that may be amenable to change that would result in a lower cost were selected for one-way sensitivity analysis.

2.2.7.3. Comparison of In-centre and Satellite Unit Yearly Haemodialysis Costs

The yearly cost of haemodialysis in the In-centre unit was compared to the yearly cost of satellite haemodialysis. The yearly cost of haemodialysis in the satellite unit was determined for both the actual patient numbers as well as patient numbers at the same capacity as the In-centre unit. To do this, the percent capacity the In-centre unit was operating at was determined in order to calculate patient numbers for similar capacity in the satellite haemodialysis program.

Differences in cost categories between the In-centre and Satellite units were identified for further exploration, including sensitivity analysis. The impact on cost of moving a Satellite Patient to an In-centre unit was explored. The impact of this move on total cost, including patient travel cost was determined.

2.2.7.4 Sensitivity Analysis

The impact of change in staff mix was determined for the In-centre unit. Using the GRASP data and the salaries of the In-centre dialysis staff the cost impact of replacing registered nursing patient care time with less expensive personnel was explored. One-way sensitivity analysis was used as the items chosen were independent of others [64].

Chapter 3

Results

3.1 Patient Demographics and Characteristics

3.1.1 Satellite Patients Demographics and Characteristics

The Home Dialysis Unit provides care to patients on peritoneal dialysis and satellite haemodialysis. During the year 2000, the Home Unit supported 201 dialysis patients. This number is made up of 138 peritoneal dialysis patients, 21 satellite haemodialysis patients receiving treatment in PEI haemodialysis units and 42 satellite haemodialysis patients receiving treatment in Nova Scotia. All satellite haemodialysis patients receive three treatments a week, or 156 treatments a year. For the purpose of the study, only Nova Scotia satellite haemodialysis patients were considered. All of the patients in the satellite unit had arteriovenous fistulas (AVFs).

At the time of data collection in November and December 2000, 38 of the 42 Nova Scotia satellite patients had been receiving haemodialysis in one of eight satellite dialysis units for at least 3 months. The location, size of the satellite dialysis units and distance from Halifax was determined. The results are presented in table 7.

Table 7. Nova Scotia Satellite Haemodialysis Units

Satellite Unit	Location*	Distance †	Patients	Staff	Capacity ‡
Annapolis	Health Centre	273 km	1	1	8-12
Baddeck	Local Hospital	375 km	1	1	8-12
Berwick	Health Centre	223 km	10	4	24-36
Liverpool	Local Hospital	171 km	7	2	12-18
Pictou	Local Hospital	200 km	9	4	20-30
Port Hawkesbury	Local Hospital	278 km	2	1	12-18
Springhill	Local Hospital	224 km	6	2	12-18
Truro	Regional Hospital	100 km	6	3	12-18

* Location is physical location, i.e. in a local hospital, in a health centre, etc.
† Distance from QE II HSC
‡ Capacity assumes two shifts per day – 3 shifts per day

Data in table 7 shows that there is a fair degree of size variation in the satellite units. All the satellite units are also operating at less than full capacity. Both of these factors impact on the cost of certain resource items and on the cost comparison with the In-centre unit, which operates at nearly full capacity. Therefore, for the purpose of the study individual patient data on medication use was collected on all 38 Nova Scotia satellite patients. For some cost items, such as water treatment the Berwick satellite unit was chosen as the representative unit to collect cost data. For other cost items, such as On-call support, the total cost for the Home Dialysis unit was divided by the total number of patients supported by this resource. For each resource the number of patients used in the determination is clearly stated.

3.1.2 In-centre Haemodialysis Patients

Data collected in December 2000, and presented in table 8, revealed that 99 outpatients were receiving dialysis treatments on Monday, Wednesday, Friday and 97 patients were receiving treatments on Tuesday, Thursday, and Saturday. All patients on haemodialysis in the In-centre unit receive treatment three times a week, or 156 treatments a year.

Table 8. In-centre Unit Haemodialysis Patients

	Section 1 – 5 *			Section 6 †		
Date	AM	Mid-Day	PM	Am	Mid-Day	PM
Dec 4,2000	28	28	17	9	9	8
Dec 5,2000	28	28	25	9	9	0
Dec 6,2000	28	28	16	9	9	9
Dec 7,2000	28	27	23	8	9	0
Dec 8,2000	28	28	16	9	9	9
Dec 9,2000	28	28	23	9	9	0

* Section 1 – 5 is the total care In-centre dialysis unit.

† Section 6 is an In-centre satellite haemodialysis unit.

There were 152 patients receiving treatment in the total care unit and 45 patients receiving treatment in the modified care unit. The In-centre unit capacity was 222 patients in 2000; therefore, the unit was at 89 % of capacity.

For the purpose of the study, the satellite patients were compared to the total care In-centre patients. To choose the In-centre patients, the following was done. From the list of all the In-centre patients that was updated in September 2000, all

the patients receiving treatment in section 6 were excluded (45 patients). From the remaining 152 patients the investigator chose those patients who would have been on haemodialysis for at least three months at the time of data collection in November and who in his opinion would be possible satellite candidates. Seventy patients were excluded, as they were not considered satellite candidates, while 21 patients were excluded, as they would not have been on dialysis for at least three months at the time of data collection in November 2000. Data was then collected on the 61 remaining patients.

At the time of data collection in November and December 2000, these 61 patients were reclassified to ensure that they would still be satellite candidates. This was done as the medical or vascular access status of the patient may have changed. The original 61 patients were reclassified as satellite candidates, or not satellite candidates because of medical or access-related problems.

Satellite candidate means that the patient could receive dialysis in a satellite unit. Patients not considered satellite candidates for medical reasons have a medical problem, such as heart disease that precludes them from being suitable for a satellite unit where Registered nurses are not present (Appendix B). Patients without well functioning AVFs are also not satellite candidates.

Table 9 shows the type of dialysis access in the In-centre patients based on their satellite suitability. Satellite suitability was determined in November 2000, and based on the patient criteria for satellite units in appendix B.

Table 9. Haemodialysis Access and Satellite Suitability of In-centre Unit Study Patients

Satellite Candidate	AVF *	CVC †	Total
Yes	37	5	42
No, Medical Reasons	6	2	8
No, Access Reasons	3	8	11
Total	46	15	61

* AVF is arteriovenous fistula or graft.
† CVC is a central venous catheter.

Of the initial 61 patients considered satellite candidates in September of 2000, by November of 2000, only 37 fulfilled all the eligibility criteria for satellite units. Fifteen patients had CVC. Five of these patients were still considered satellite candidates as an AVF had been created, but was not yet used. Eight patients with CVCs were no longer satellite candidates as it was felt they would never have an adequate AVF. Some of the initial 61 patients with AVF were reclassified as not satellite candidates if there was a change in their overall medical condition (6/46) or problems with their AVF (3/46). Change in status is a result of the multiple medical conditions that most dialysis have as well as the well-documented difficulties in maintaining adequate vascular access.

3.1.3 Comparison of Demographics and Characteristics of Satellite and In-centre Patients

The initial analysis done compares the initial 61 In-centre patients with the 38 satellite dialysis patients. The results of this analysis are shown in tables 10 and 11.

Table 10. Demographics of In-centre and Satellite Haemodialysis Patients

Demographic		In-centre (N= 61)	Satellite (N = 38)
Age	Mean	69 years	61 years
	SD *	13.12 years	13.79 years
	range	37 – 90 years	27 – 85 years
Dialysis duration	Mean	32 months	37 months
	SD *	40 months	29 months
	range	5 – 217 months	4 – 132 months
Gender	M: F	28:33	24:14
	%	46%: 54%	63%: 37%
Race	% Caucasian	92 %	97 %

* Standard Deviation

As shown in table 10, the In-centre patients were older and duration of dialysis was shorter, although the ranges for both age and duration of dialysis were quite broad. Although gender distribution was equal in the In-centre patients, there were more men than women in the satellite units. The majority of patients in all units were Caucasian.

Table 11. In-centre and Satellite Patients - Aetiology of Renal Failure and Co-morbidities

Aetiology of Renal Failure	In-centre N = 61	Satellite N = 38
Diabetes	29 %	13 %
Hypertension	34%	10.5 %
PCKD*	3 %	10.5 %
GN †	13 %	37 %
Other ‡	16%	29%
Unknown §	5 %	0%
Co morbidities		
Hypertension	77 %	60.5 %
Cardiovascular Disease	61%	10.5 %
Diabetes	39%	13%
Stroke	9.8%	0 %
Peripheral Vascular Disease	26%	2.6%
Amputation	6.6%	0%

* Polycystic Kidney Disease
† Glomerulonephritis
‡ Other documented kidney disease
§ Aetiology unknown or undocumented

Hypertension and diabetes were the most common reasons for CRF in the In-centre population, while glomerulonephritis and other renal diseases were more common in the satellite unit. All the co-morbidities were more prevalent in the In-centre patients.

In order to explore whether excluding certain groups of In-centre patients would impact on the differences between In-centre and Satellite groups table 12 shows

the results of comparing all the in centre patients chosen, as well as two subgroups of the inpatients with the satellite patients.

Table 12. Comparison of In-centre and Satellite Haemodialysis Patients

	1 * All In-centre (N= 61)	2 † In Centre AVF (N=46)	3 ‡ Scand and AVF (N=37)	4 § Satellite (N = 38)
Age mean (SD)	69 (13.12)	69 (14)	71 (14)	61 (13.79) ¶
Dialysis duration mean (SD)	32 months (40)	35 months (43)	30 months (41)	37 months (29) ¶
Gender M:F (%)	28:33 (46:54)	23:23 (50:50)	19:18 (51:49)	24:14 (63:37)
Race % Caucasian	92 %	91 %	97%	97 %
Aetiology Renal Failure				
Diabetes	29 %	30%	30%	13 %
Hypertension	34%	37%	41%	10.5 %
PCKD	3.0 %	0.0%	0.0%	10.5 %
GN	13 %	15%	19%	37 %
Other	16%	13%	5.0%	29%
Unknown	5.0%	4.0 %	5.0%	0.0%
Co-morbidities				
Hypertension	77 %	78%	81%	61 %
CVD	61%	54%	57%	11 %¶
Diabetes	39%	39%	41%	13 % ¶
Stroke	9.8%	11%	11%	0.0 %¶
PVD	26%	28%	24%	7.0 %¶
Amputation	7.0%	2.0%	3.0%	0.0 %¶

* Group 1 includes all the In-centre patients chosen.
† Group 2 is all of the In-centre patients chosen with AVFs.
‡ Group 3 is all the In-centre patients chosen with AVFs that were considered satellite candidates.
§ Group 4 is the satellite patients.
¶ Group 4 statistically different from Groups 1,2,or 3.

Comparing group 2, all in centre patients with AVFs, to group 4, all satellite patients, the In-centre patients were significantly older (p = .009 Mann-Whitney), and had been on dialysis a shorter time (p = .051). All co-morbidities were all significantly higher in the In-centre patients, except for amputations, which was not significant due to small numbers.

Comparing group 3, all In-centre patients with AVF's who were satellite candidates, to group 4, all satellite patients the satellite patients were younger, but had still been on dialysis longer. Diabetes and hypertension were the most common aetiologies of renal failure in the In-centre patients, while glomerulonephritis and other renal diseases were the most common causes in the satellite patients. All co-morbidities were more prevalent in the In-centre patients

In summary, comparing the demographics and the characteristics of any of the In-centre patient groups to satellite patients the In-centre patients were older and had been on dialysis for less time than the satellite patients. Diabetes and hypertension were the most common aetiologies of renal failure in the In-centre patients, while glomerulonephritis and other kidney diseases were the most common in satellite patients. In-centre patients also had more co-morbidities than the satellite patients. The differences between the satellite and In-centre patient groups did not change when the In-centre patients that were no longer considered satellite candidates were excluded. The number of amputations in the

In-centre patients decreased when patients without AVFs were excluded. Further analysis revealed that patients with CVC had more amputations.

3.2.0 Resource Costs

3.2.1 Staff Costs

3.2.1.1 Satellite Staff costs

3.2.1.1.1 Physician Costs

The Nephrology program at the QE II HSC had eight full time nephrologists in 2000. For patient care, a service rotation is made with one nephrologist being assigned to the In-centre haemodialysis unit each month and one nephrologist assigned to the Home dialysis unit. An on-call schedule assigns one nephrologist to each week night and weekend day, and at these times one nephrologist would provide medical coverage for not only the In-centre dialysis unit and Home unit, but also the inpatient wards and consultations.

Physician reimbursement for service provided was as per the Provincial fee schedule. In 1999, an Alternative-funding Plan (AFP) was negotiated between the Department of Health and the Department of Medicine at the QE II HSC. In order to determine the cost of physician services for maintenance haemodialysis in 2000 the fee payment from before the AFP was used. At that time the fees paid for medical care of a satellite haemodialysis patient was $156.87 per patient per month, which also included the quarterly clinic reviews. Under the AFP, which was in effect during 2000, the same fees would be valid as AFP Physician

remuneration was based on fee for service activity. Therefore, the cost per satellite dialysis patient per year for nephrologist care is $1882.44.

Analysis of the individual patient data collected by the physicians showed that the mean time required for patients by the nephrologist in a year was 2.97 hours (Range 0.4 – 7.60 hours). In addition to this is the quarterly 30-minute clinic visits. The total time per year would average 5 hours. This time does not include any administrative time for the Medical Director of Dialysis.

3.2.1.1.2 Administration Staff Costs

Satellite Haemodialysis Administrative Staff

3.2.1.1.2.1 Satellite Haemodialysis - Nurse Manager

The Nurse Manager responsible for the Home Dialysis program, Outpatient renal Transplant and general nephrology clinic estimated that the time spent on the Nova Scotia satellite haemodialysis units was 11 hours per week. This amounts to 572 hours a year or 29.3 % of the total paid hours for the year (total paid hours are 1950). From the Administrative Nursing Staff Scale 5 this equates to $20,171.85. This amount divided by the 42 Nova Scotia satellite patients equals $480.28 per satellite patient per year for Nursing Administration. If the yearly salary of the Nursing Manager were divided equally among the 201 Home Unit dialysis patients, the cost per patient per year would be $342.52 per satellite dialysis patient per year.

3.2.1.1.2.2 Satellite Haemodialysis - Administrative Secretary

A half time administrative secretary is assigned to the Home Dialysis unit. Salary with benefits for the half time position is $15,845.04. This amount divided by all 201 dialysis patients supported by the Home Dialysis Unit equates to $78.83 per patient per year for administrative secretary support.

3.2.1.1.2.3 Satellite Haemodialysis - Unit Clerk

One unit clerk working full time is paid salary level 5, or $30,735.25 a year. Another unit clerk works part-time at pay level 2, or $14,378.55 a year. The total salary for Home Unit clerks is $45,113.80. If this is equally divided among the 201 Home Unit patients, the cost per patient per year for Unit Clerk resources is $224.45. The unit clerk working the one FTE is paid at a level 5 pay scale for 140 hours a month. The unit clerk working a .5 FTE is paid at a level 2 pay scale for 70 hours a month.

3.2.1.1.3 Satellite Haemodialysis Home Unit Support Staff

3.2.1.1.3.1 Home Unit Charge Nurse

Analysis was done of the individual patient data collected by the Home Unit charge nurse. The mean time of Charge nurse utilization per Nova Scotia satellite Haemodialysis patient in 2000 was 4.89 hours (Range 0 – 21.2 hours). Using the RN salary scale 6, this equates to $134.65 per patient per year.

3.2.1.1.3.2 Home Unit On-Call Nurse

The total budget for Home unit on-call for the year 2000 was $50,000.00. $50,000.00 divided by all 201 Home Unit patients that receive on-call support (63 satellite haemodialysis and 138 peritoneal dialysis) equals $248.76 per patient per year for on-call support.

3.2.1.1.3.3 Home Unit Clinic Nurse

Each satellite haemodialysis patient travels to Halifax at least four times a year to be seen in the clinic. Each visit requires 30 minutes of nursing care. Using the RN salary scale 6 and 2 hours, this calculates to $55.07 per patient per year for clinic nursing resource.

3.2.1.1.3.4 Home Unit Haemodialysis Nurse

One of the Home Dialysis nurses has the role of Satellite haemodialysis coordinator. This job involves coordination of patient care in the satellite haemodialysis units and clinic visits for both the Nova Scotia and PEI satellite haemodialysis patients. The job involves 3 hours per week, or 156 hours a year. Using RN pay scale 6 and 63 patients, this calculates to $4295.52/63 or $68.18 per patient per year.

3.2.1.1.3.5 Illness and Vacation Relief

For the year 2000, 15 sick relief days were recorded for the Berwick satellite unit. Each sick relief day involves 16 hours of pay to the relief nurse to cover travel time and work time. Therefore, 240 hours of sick relief were attributed to the

Berwick Satellite Unit. All the hours are paid at the RN salary scale 6, which calculates to $6608.49. This amount divided equally among the 10 patients receiving treatment in the Berwick unit amounts to $660.85 per patient per year for sick relief. The cost of travel, per diem food allowance and any hotel costs were not collected.

3.2.1.1.3.6 Satellite Dialysis Assistant

Dialysis Assistants are paid 6 hours for each dialysis treatment, and each patient receives 156 treatments a year. Using the Dialysis Assistant pay scale the cost per dialysis treatment is $107.70. The cost per patient per year for Dialysis Assistant care is $16,801.48.

Table 13 provides a summary of the Satellite Staff costs and whether the cost is fixed or variable. The definition of fixed is somewhat arbitrary as there would be a patient number, which could be different depending on the resource category, beyond which increased staff resources would be needed [57] . At that point, the cost savings realized by increasing patient numbers would change, as a new cost per patient would need to take into account the increased resources.

Table 13. Satellite Staff Costs - Summary

	Fixed Cost	Variable Cost	Cost/Patient/Year
Nephrologist		√	$1882.44
Nursing Manager	√		$480.28*
Admin Secretary	√		$78.83*
Unit Clerk	√		$224.45*
HD Nurse	√		$68.18*
Charge Nurse	√		$134.65*
Clinic Nurse		√	$55.07*
On Call Nurse	√		$248.76*
Sick Relief		√	$660.85
Dialysis Assistant		√	$16,801.48
Total Dialysis Staff Cost			$20,634.99

* Denotes Home Unit Support Staff (subtotal $1,290.22; see text below)

As Shown in Table 13, the major contributor to staff costs are the dialysis assistants. Of note is the amount of Home Unit Support Staff required for each satellite patient. The cost per satellite patient per year for Home Unit Support totals $1,290.22.

3.2.1.2 In-centre Staff

3.2.1.2.1 Physician Costs

3.2.1.2.1.1 Nephrologist Costs

Physician reimbursement for service provided was as per the Provincial fee schedule. In order to determine the cost of physician services for maintenance haemodialysis in 2000 the fee payment from before the Alternative Funding Plan was used. The fee paid to nephrologists for care given to patients on dialysis in hospital or In-centre haemodialysis units was $66.15 per patient per treatment. This fee was paid to cover the cost of all haemodialysis related medical care of the patient. This reimbursement is substantially higher than the reimbursement for satellite haemodialysis. The reasons for the difference are several, the main one being that the reimbursement fee compensates for more than routine maintenance dialysis care. In-centre patients range from relatively medically stable outpatients to gravely ill patients in the hospital. All patients starting haemodialysis receive treatment in the In-centre unit, and the start of dialysis requires more medical and dialysis access care. The In-centre patients are seen at every treatment, and also receive more primary medical care from the nephrologist, as compared to the satellite patients, who are seen by family doctors. Therefore, the yearly fee paid for physician care for a patient receiving 156 treatments in an In-centre unit is $10,319.40. No additional administrative costs were included.

3.2.1.2.1.2 Extended Role Nurse Costs

During 2000, one ERN worked full time and one worked 80% of a full time equivalent. Each ERN spent six months in the In-centre dialysis unit. The ERN salary for 2000 was calculated as (6 months of pay scale 3) plus (.8 {6 months of pay scale 2}). This equates to $30,755.63 plus $24,032.47 for a total of $54,788.10 for the year 2000 for ERN resource in the In-centre haemodialysis unit.

The number of patients the ERN was responsible for was 44 – 56 a day for 5 days a week. This is an average of 50 patients day, 250 patient treatments a week, or 13,000 treatments in the year. One ERN working full time for 6 months would see 6500 patients, while one ERN working .8 would see 5200 patients. The total salary for the year was $54,788.10 divided among the 11,700 total patients seen equates to a cost of $4.68 per patient treatment. If each haemodialysis patient were seen by the ERN at each treatment, this would equate to a yearly cost of $730.51.

Analysis of the individual patient data collected revealed that the yearly mean hours of ERN resource required by the In-centre patient was 6.33 hours (range 0 to 12.8 hours. An estimated yearly cost, using ERN pay scale 3 is $199.67 (Range $0.00 to $403.77). This cost is substantially less than the cost derived from the actual yearly salary, and therefore, the individual patient data cost was not used.

3.2.1.2.2 Administration Staff Costs and 3.2.1.2.3 Nursing Staff

In table 14, the data extracted from the payroll reports of the In-centre unit is presented by staff category. The number of staff employed in each category is also listed.

Table 14. In-centre Salaries and Benefits - Actual Cost

Category	Staff Number*	Salary and Benefits 2000
Nurse Manager	1	$56,443.15
Administration Secretary	1	$15,845.04
Unit Clerk	4	$79,759.39
Total Management	6	$152,047.58
Ward Aide	9	$71,342.12
Renal Assistant	14	$366,597.77
LPN	6	$198,640.03
Registered Nurse	67	$2,626,832.86
Total Dialysis Staff	96	$3,263,412.78
Total Management and Staff	102	$3,415,450.30

* Staff number, not FTE's

Based on 30,003 In-centre treatments or runs in 2000, the cost per run can be calculated for:

1. Management:

   $152,047.58 / 30,003 runs = $5.07 per run or $790.06 per patient treatment year.

2. Staff:

   $3,263,412.78 / 30003 runs = $108.77 per run or $16,968.12 per treatment year

Total cost for treatment year = $17,758.18

Summary of In-centre Dialysis Costs

Table 15. In-centre Haemodialysis - Staff Costs

	Fixed Cost	Variable Cost	Cost/Patient/Year
Nephrologist		√	$10,319.40
ERN	√		$730.51
Nursing Manager	√		$293.48
Admin Secretary	√		$82.39
Unit Clerk	√		$414.71
Total Cost			$11,840.49

Table 15 displays the staff costs in the In-centre unit. The majority of staff costs are physician fees.

Table 16. In-centre Haemodialysis - Nursing Staff Costs

	Fixed Cost	Variable Cost	Cost/Patient/Year
Registered Nurse		√	$13,658.17
LPN		√	$1,032.82
Renal Assistant	√		$1,906.12
Ward Aide	√		$370.94
Total Cost			$16,968.05

Registered nursing accounts for the largest share of the nursing costs, as shown in table 16. Registered Nursing and LPN costs were considered variable costs, as there is a relatively set nurse or LPN to patient ratio in the In-centre unit. Renal Assistants and Ward Aides work on a per shift basis.

3.2.1.3. Dietitian and Social Worker Costs

The results of the analysis of individual patient resource utilization of Social Workers and Dietitians are presented in the table 17.

Table 17. Dietitian and Social Worker Resource Utilization

	In-Centre (N = 46)	**Satellite** (N = 38)	**p-value ***
Dietitian Time	2.38 hours	0.52 hours	
Mean (SD)	(1 .00)	(0.59)	.004
Range	0-4.67	0 – 2.67	
Social Worker Time	1.8 hours	1.0 hours	
Mean (SD)	(3.93)	(3.5)	.082
Range	0 – 20.6	0 – 20.8	

* Mann-Whitney U Test

Dietitians spent significantly more time with In-centre patients. Using the Dietitian 2B pay scale 6 salary (Appendix D), the yearly mean cost of this resource in 2000 was $72.85 for the In-centre patient and $15.92 for the Satellite patient.

Patient utilization of Social Workers was not different between the two patient groups. Using the Social Worker 2B pay scale 6, the yearly mean cost of this resource in 2000 for In-centre patients was $55.10, while the cost for the Satellite patient was $30.61.

3.2.2 Haemodialysis Supplies and Machines

3.2.2.1 Haemodialysis Supplies

The prices for each supply item needed for a dialysis treatment are listed in table 18 below and a total determined.

Table 18. Supply Costs for Haemodialysis Treatment

Cost Item	Cost per Item In-centre	Cost per Item Satellite
Blood Lines	$8.00	$8.00
Dialyzer *	$9.00	$21.00
Fistula Needles	$1.30	$1.30
Gloves, 2 pair	2 x$ .10	2 x$ .10
IV Line	$.79	$.79
Heparin syringe	$1.09	$1.09
Protector Transducer	$.40	$.40
Chloride test strip	$.40	$.40
Dixie cup	$.04	$.04
Saline	$2.03	$2.03
Acid bath (K3)	$4.99	$4.99
Calcium Spike	$2.70	$2.70
NaHCO3	$3.08	$3.08
Antiseptic solution	$.10	$.10
2X2 dressing	$.22	$.22
TOTAL COST	**$34.34**	**$46.34**

* A different dialyzer is used in each unit.

In the In-centre unit a dialyzer is reused 10 times and the cost per treatment for the dialyzer is a composite of:

1. Capital cost of the dialyzer, which is $40.00.
2. Cost of reprocessing the dialyzer, this is $5.00 per each reprocessing.

$40.00/ 10 + $5.00 = $9.00 per treatment.

Cost for treatment supplies in the In-centre unit with a reused dialyzer is $34.34 per treatment or $5,357.04 per patient per year (156 treatments per year).
In the Satellite unit a single use dialyzer is used, which increases the cost for treatment supplies to $46.34 per treatment or $7,229.04 per patient per year.

3.2.2.2 Haemodialysis Machines

3.2.2.2.1 Capital Cost of the Haemodialysis Machine

Table 19 lists the various dialysis units in Nova Scotia and the number of dialysis machines in each area.

Table 19. Number of Haemodialysis Machines

Dialysis Unit	Dialysis Machines
In-Centre Section 1 – 4	22
In-Centre Section 5	7
In-Centre Section 6	9
In-Centre Spare machines	11
Total machines In-centre	49
Berwick Satellite Unit	7
All Satellite Units	34

The cost of each dialysis machine is $25,000.00. Each dialysis machine has a life span of 10 years or 40,000 hours, with no machine value at the end of the lifespan, except occasional parts that are salvaged to repair other machines. Machines that are 10 years old with less than 40,000 hours are still replaced and do not have any residual value.

In a busy, In-centre haemodialysis units each dialysis machine is employed for 3 dialysis treatments (runs) per day for 6 days a week for 52 weeks or 936 runs per year. If each run were 5.5 hours (4 hours treatment plus set-up and cleaning), each machine would accumulate 5,148 hours per year. Machines in Satellite units may not be used as often, depending on the number of patients..

Table 20 compares the number of runs per machine in the In-centre unit and the satellite unit. An estimation of runs per machine with the unit at similar patient capacity as the In-centre unit is also shown.

Table 20. Haemodialysis Machine Treatment Capacity

Unit	Treatments	Machines	Runs/machine
In-centre Actual	30003	49	612
Berwick Satellite Actual	1560	7	223
Berwick Satellite 89 % Capacity	4992	8 *	624

* Estimated that at least one additional spare machine would be needed.

The previous table shows that increasing the number of patients in the Satellite unit similar capacity as the In-centre unit results in a similar number of runs per dialysis machine.

Yearly Cost of a Haemodialysis Machine

For the purpose of the study the full capital cost of a dialysis machine was converted to an annual cost. Appendix E shows the method of calculating annual cost as recommended by Drummond [57] . Similar results for annual cost can be obtained by using an Excel Financial PMT Spreadsheet, which calculates the payments on a loan based on constant payments and a constant interest rate. This method has been used to calculate annual capital cost [62] . Variables entered are: interest rate for the period, number of years (payments), present value of the machine, net value of the machine and payment at the beginning or end of the payment period.

Table 21 shows the results calculated for the yearly cost of a dialysis machine.

Table 21. Annual Capital Cost of a Haemodialysis Machine

Rate	Years	Present Value	Net Value	Payment Time	Yearly Cost
0.05%	10	$25,000.00	0	End of period	$3,237.61

3.2.2.2.2 Haemodialysis Machine - maintenance and repair costs

Cost of machine maintenance and repair is a composite of three components:

4. Salary for the dialysis technician
5. Parts for the machine
6. Travel costs when servicing machines in the satellite unit.

The salary for the technician was obtained from the financial office of the QEII HSC. The dialysis program employed four technicians for the year 2000 and an average salary was $21.9507 per hour ($25.9018 per hour with 18% benefits added). The cost of machine parts for each unit was obtained from the records of the Chief technician, as were the costs for travel hours. The technician who travels to a satellite unit to repair a machine is paid their hourly salary for the time travelling, as well as the time spent servicing the machine(s). They are also reimbursed for the distance travelled at the standard rate paid by the QE II HSC, which is $0.315 per km. Tables 22, 23 ands 24 contain information about labour hours, travel hours, cost of machine parts, and total machine maintenance costs for the year 2000.

Table 22. Haemodialysis Machine Maintenance - Labour

	In-centre Unit	Berwick Satellite
Labour Hours	3857.1	211.5
Travel Hours	48.75	129
Total Hours	3905.85	340.5

Using the average salary of the technician, the cost for labour and travel for the In-centre unit was $25.9018 times 3905.85 = $101,168.49. The cost for the Berwick Satellite unit was $25.9018 times 340.5 = $8,819.56.

Table 23. Haemodialysis Machine Maintenance - Costs for 2000

	In-centre Unit	Berwick Satellite
Labour Cost	$101,168.55	$8,819.56
Travel Cost	0.00 *	$2910.60
Parts	$58,361.00	$7571.00
Total Cost	$159,529.55	$19,301.16

* No travel costs, as machines in two local hospitals are only five blocks apart.

In order to calculate a cost per patient a year for dialysis machine the sum of the annual cost of the dialysis machine and the total cost of maintenance for the unit was divided by the number of treatments in each unit to obtain a cost per treatment. A cost per patient per year was obtained by the product of the cost per treatment and the number of treatments in a year.

Table 24. Haemodialysis Machines - Satellite Unit Costs in 2000

Cost category	Quantity	Cost/quantity	Total cost
Machines	7	3,237.61	$22,663.27
Maintenance hours	211. 5 hours	25.9018/hour	$5,478.23
Travel hours	129 hours	25.9018/hour	$3,341.33
Travel cost	9240 km	0.315/km	$2,864.40
Machine Parts	N/A	N/A	$7,571.00
Total			$41,918.23
Treatments in 2000	**(10 patients x 156 treatments**		1560
Cost per treatment			$26.87

The cost per patient per year in the satellite unit for Dialysis machines is $4191.90, which is a composite of a yearly capital cost of $2,266.33 and a yearly maintenance cost of $1,925.50. If the satellite unit were at a similar capacity as the In-center unit, with 32 patients and 8 machines, the cost per patient per year for Dialysis machine capital cost would decrease to $809.40. The yearly cost for machine maintenance would also decrease to $687.68 per patient per year. This is shown later in table 39.

Table 25 lists the cost components of haemodialysis machine costs for the In-centre unit with a final cost per treatment.

Table 25. Haemodialysis Machines - In-centre unit Costs in 2000

Cost category	Quantity	Cost/quantity	Total cost
Machines	49	$3,237.61	$158,642.89
Maintenance hours	3857.1 hours	$25.9018/hour	$99,905.83
Travel hours	48.75 hours	$25.9018/hour	$1,262.71
Travel cost	0	$0.315/km	$0.00
Machine Parts	N/A	N/A	$58,361.00
Total			$ 318,172.43
Treatments in 2000			30003
Cost per treatment			$ 10.60

The cost per patient per year in the In-centre unit for Dialysis machines is $1,653.60.

3.2.2.3 Haemodialysis Water Treatment

The total cost of water treatment contains four components:

1. Capital cost of equipment
2. Parts: membranes, filters, including shipping of parts to satellite units.
3. Labour costs for maintenance, repair and cleaning.
4. Quality assurance testing and documentation.

3.2.2.3.1 Haemodialysis Water Treatment - Capital Cost

3.2.2.3.1.1 Capital Cost Berwick Satellite Haemodialysis Water Treatment

Two types of water treatment are used in the satellite units. DI systems remove minerals and ions from local water to make it suitable for haemodialysis. The cost of using a DI system is somewhat dependant on the local water quality. Ion tanks require regeneration when they become depleted. Reverse Osmosis is the other system used to treat water for satellite haemodialysis. In the Berwick satellite, a DI system was used for the majority of water from January to April 2000. From April 2000 on a Biopure Reverse Osmosis system was used for the bulk of water used. The DI system was maintained as a back up system. Capital costs for both systems were divided over an estimated 20-year lifespan.

Tables 26 and 27 show the Excel Spread sheet method of obtaining the annual Capital cost of the water treatment systems for the Berwick satellite unit.

Table 26. Berwick Reverse Osmosis Water Treatment System - Annual Capital Cost

Biopure RO System

Rate	Years	Purchase cost	Net Cost	Pay Period	Yearly Cost
0.05	20	$16,000.00	$0.00	End of period	$1,222.74

Table 27. Berwick DI Water Treatment System - Annual Capital Cost

DI Water Treatment System

Rate	Years	Purchase cost	Net Cost	Pay Period	Yearly Cost
0.05	20	$10,000.00	$0.00	End of period	$802.43

3.2.2.3.1.2 Capital Cost In-centre Unit Haemodialysis Water Treatment

Two systems are used to provide the total amount of water needed for the in centre dialysis units; a Culligan System with a purchase price of $65,000.00 and a Biolab System with a purchase price of $95,536.00. Both systems were estimated to have a life span of at least 20 years.

The same Excel Spread sheet method as used for the dialysis machines was also done and is shown below in table 26 [57;62] .

Table 28. In-centre Haemodialysis Water Treatment - Annual Capital Cost

Rate	Years	Present value	Net value	Payment time	Yearly Cost
0.05%	20	$160,536.00	0	End of period	$12,881.82

3.2.2.3.2 Cost of Haemodialysis Water Treatment Parts

The cost of all parts needed to maintain the water treatment systems were obtained from the records of the Chief Dialysis Technician. They are listed in the summary Tables below.

3.2.2.3.3 Cost of Labour for Maintenance and Repair of Haemodialysis Water Treatment System

The cost of labour to maintain and repair each water treatment system was obtained from the records of the Chief Dialysis Technician. For the In-centre unit review of the performance log requires a ½ hour per system per day, except stat holidays. A renal technician does the log review. The cost for this is the product of the number of hours and the salary of the technician. Each system requires 177.5 hours (0.5 hours times 355 days) a year at an average salary cost of $25.90 per hour. In the Satellite Units, both water treatment systems are disinfected on a regular basis. This is done by the Dialysis Assistants in the Satellite Units. The cost for disinfecting each system is the product of the number of hours spent and the salary of the dialysis assistant.

3.2.2.3.4 Haemodialysis Water Treatment - Quality Assurance

Samples of water are sent from each treatment system four times a year. For the In-centre unit for each quarterly analysis a sample of feed water and a sample of product water are sent for each system. For the Berwick satellite unit the feed water is the same for both systems, therefore, for each quarterly analysis one feed sample and two product samples are sent for analysis.

Bacterial testing is done on all systems and consists of endotoxin testing and total plate counts which are preformed on the In-centre water samples and a Millipore bacterial tester, which is used in the satellite units. For the In-centre unit Culligan system one sample of product water is sent monthly for total plate count and endotoxin testing. For the Biolab system, which is used for dialyzer reuse processing six samples from various locations in the system are sent weekly for total plate count and endotoxin testing. In the Berwick satellite unit, a product water sample from each system is tested monthly with a Millipore bacteria tester. In all systems, additional samples may be required if previous samples results were abnormal.

Table 29 displays the routine samples sent from each system in the year 2000.

Table 29. Routine Water Samples for Quality Assurance in 2000

	In-centre Unit		Satellite Unit	
Test	Culligan	Biolab	DI System	RO System
Water Quality	8	8	8	4
Endotoxin Test	12	312	--	--
Total plate Count	12	312	--	--
Millipore Bacteria Test	--	--	12	12

Table 30 contains information obtained from the QE II HSC laboratory on the type of test, the cost of each test.

Table 30. Cost of Water Quality Tests

Test	Cost per test
Endotoxin Test	$15.00
Total plate Count	$15.00
Water Quality Test	$133.00
Millipore Bacteria Test	$133.00

Data was obtained from the QEII HSC laboratory on the total number of test done in the year 2000 and the costs. As the bacterial tests are done only on the In-centre water, the total number of tests and costs could be used.

Tables 31 to 33 present the annual cost of water treatment based on the information obtained.

Table 31. Berwick Satellite DI Water Treatment Costs for 2000

Cost Item	Cost per year
Capital Cost	$802.43
DI tank regeneration and shipping *	$9,234.00
Prefilters	$40.00
Carbon Rebedding	$448.00
Ultra filter Replacement	$180.00
Weekly Disinfecting †	$2,766.41
Quarterly System Disinfections	$283.73
Quarterly Quality Analysis ‡	$798.00
Monthly Bacteria Testing	$55.20
	Total = $14,607.77

* DI regeneration cost of shipping and the regeneration represents the costs of shipping the DI tanks to and from the satellite unit to the manufacturer for regeneration.

† The Dialysis Assistant in satellite unit is responsible for disinfecting the system, which takes three hrs/week, and are paid their hourly wage for this.

‡ Only one feed water sample required for two systems, so 4 samples per year divided by the two systems.

Table 32 lists the cost components of the Biopure Reverse Osmosis System in the Berwick satellite unit for the year 2000.

Table 32. Berwick Satellite RO Water Treatment Costs for 2000

Cost Item	Cost per year
Capital Cost	$1,283.88
Carbon Tank Regeneration	$448.00
Membrane Replacement	$1,066.00
Maintenance/Repairs	N/A *
Monthly Disinfecting (2 hours a month)	$425.60
Quarterly Quality Analysis	$798.00
Monthly Bacteria Testing	$55.20
	Total = $4,076.68

* Not available as system had only been in place several months.

The total cost of water treatment for Berwick in 2000 was $18,684.45. The total number of treatment runs in Berwick in 2000 was 1560 (10 times 156). Therefore, the cost per run for water treatment is $11.98 or a cost per year for water treatment of $1,868.45. If the Satellite unit were operating at the same capacity as the In-centre unit, with 32 patients or 4992 runs in a year, the cost for water treatment would be $3.74 per treatment or $583.89 per treatment year.

Table 33 lists the cost components and total cost of the water treatment for the In-centre unit.

Table 33. Haemodialysis Water Treatment - In-centre Costs for 2000

Cost Item	Culligan System	Biolab System	Total Cost
Annual Capital Cost	$5,215.77	$7666.06	$12,881.82
Labour	$4,675.00	$9272.00	$13,947.00
Carbon rebedding	$4,800.00	N/A *	$4,800.00
Prefilters	$882.00	N/A *	$882.00
Membranes	$3,520.00	N/A *	$3,520.00
Water Quality Testing	$1064.00	$1064.00	$2128.00
Bacteria and Endotoxin Testing	N/A †	N/A †	$28,035.00
Daily Performance Log	$4,597.25	$4,597.25	$9194.50
		Total = $75,388.40	

* N/A is not applicable, as not a component of the system.
† N/A as only total cost available from Laboratory.

To determine a cost of water treatment per dialysis treatment for the In-centre unit, the total yearly cost of water treatment was divided by the total number of dialysis treatments in the unit. For the In-centre unit the total number of treatments in 2000 was 30,003. Of these, 265 were done outside of the In-centre unit, and therefore, did not use the water treatment system. The cost per dialysis treatment for water was $75,388.40 divided by the 29,738 treatments done in the

In-centre unit which equals $2.54 per treatment, or $396.24 for a year of treatment (156 treatments per year).

3.2.3 Laboratory Tests and Medications

3.2.3.1 Laboratory Tests

The frequency and type of laboratory tests was taken from the routine blood work done on all haemodialysis patients. The laboratory tests listed are the standard obtained from all patients, usually on a monthly basis, although some tests are done less frequently.

Costs for tests were obtained from the QEII laboratory, which uses the Nova Scotia Department of Health, and Fitness Laboratory Equity System. This system assigns a credit to each laboratory test based on time studies for manpower, capital cost and depreciation of equipment, as well as all materials and reagents needed to perform each specific test, and the credit is converted to a dollar value for reimbursement to the lab.

Table 34 lists the specific laboratory tests done and their frequency, as well as the cost per test and the yearly cost of the test. The cost per patient per year for routine laboratory tests is $1450.00.

Table 34. Haemodialysis Related Routine Laboratory Tests

Laboratory Test	Frequency	# /year	Cost /test	Cost/year
Electrolytes	Monthly	12	$7.46	$91.68
Glucose	Monthly	12	$2.94	$35.28
Urea; pre and post	Monthly	24	$2.94	$70.56
Creatinine; pre and post	Monthly	24	$3.53	$84.72
Calcium	Monthly	12	$3.53	$42.36
Phosphate	Monthly	12	$3.33	$39.96
Uric Acid	Monthly	12	$2.94	$35.28
Total protein	Monthly	12	$2.60	$31.20
Albumin	Monthly	12	$2.55	$30.60
Total bilirubin	Monthly	12	$3.53	$42.36
Alkaline phosphatase	Monthly	12	$3.53	$42.36
ALT	Monthly	12	$3.53	$42.36
AST	Monthly	12	$3.53	$42.36
LD	Monthly	12	$3.14	$37.68
CK	Monthly	12	$3.92	$47.04
CBC (no differential)	Twice monthly	24	$6.80	$163.20
INR	Monthly	12	$3.92	$47.04
PTH	Q 3 Months	4	$55.66	$222.64
TSH	Q 3 Months	4	$7.84	$31.36
Total Cholesterol	Q 6 Months	2	$3.53	$7.06
Ferritin	Q 2 Months	6	$17.05	$102.3
Tsat (iron and TIBC)	Q 2 Months	6	$10.58	$63.48
Hep B sAg	Q 6 Months	2	$10.39	$20.78
Hep B sAb	Q 6 Months	2	$10.58	$21.26
Hep C Ab screen	Q 6 Months	2	$19.60	$39.20
HIV	Yearly	1	$15.88	$15.88
Total Tests per patient per year		**269**		$1,450.00

3.2.3.2 Haemodialysis Related Medications

3.2.3.2.1 Cost of Heparin

The cost of heparin for a treatment year was calculated from data provided by the QE II Pharmacy Department. The cost for a 30 ml vial of heparin was $2.4652. The amount of heparin used per patient per year was calculated to be 15 ml per treatment or 2340 ml for a year. The calculated cost is $192.29 per patient per year.

3.2.3.2.2 Cost of Eprex and IV Iron

The amount of Eprex and IV iron used by each patient in the year 2000 was calculated based data collected from each patients chart. A cost per year was determined using the cost of each drug, which was obtained from the QEII HSC pharmacy department. Table 35 below shows the mean costs of Eprex and IV iron for the In-centre and Satellite patients for the year 2000.

Table 35. Haemodialysis Medications – 2000 Costs

		In-Centre N = 46	Satellite N = 38	p-value*
Eprex	cost/year	$4575.00	$4802.00	.709 *
IV Iron	cost/year	$499.00	$144.00	< .0001 *

* Mann-Whitney U Test

The results show that in centre and satellite patients received similar amounts of Eprex during the year, but In-centre patients received more IV iron.

Table 36 below provides a summary of the laboratory test and Haemodialysis medications for the year 2000, along with a total cost.

Table 36. Yearly Mean Cost of Laboratory Tests and Medications

Category	Fixed Resource	Variable Resource	In-centre Cost/Year	Satellite Cost/Year
Laboratory Tests		√	$1,450.00	$1,450.00
Heparin		√	$192.29	$192.29
Eprex		√	$4,575.00	$4802.00
IV Iron		√	$499.00	$144.00
Total			$6,716.29	$6,588.29

3.2.4 Haemodialysis Supplies - Linen

Linen is provided for patient care for each dialysis treatment. Charges for linen are based on a per pound charge which varies according to the item, sheets are charged differently than pillowcases.

The total cost for linen for the In-centre unit in 2000 was $81,555.00. This amount divided by the 29,738 In-centre unit treatment runs in the year equates to $2.7424 per treatment or $427.82 per patient treatment year.

Linen for the Berwick unit is paid for by the Valley regional hospital. The assumption was made that there is no difference in cost. Therefore, the cost per patient per year for linen used while on dialysis in 2000 was $427.82.

3.2.5 Haemodialysis - Overhead

Floor plans and room square footage for the dialysis areas was obtained from QE II HSC Engineering services. Square footage of the Satellite unit in Berwick was also obtained from the Western Kings Memorial Health Society, which owns and maintains the building where the Berwick Satellite Unit is located.

Space at the QE II HSC was assigned to In-centre haemodialysis, Home dialysis, technical space, and shared space between In-centre haemodialysis unit and home unit.

3.2.5.1 Haemodialysis Overhead - Utilities

The cost of utilities per square foot was obtained form the Physical Plant Records of the QE II HSC. Annual expenditure per square foot in 2000 was $3.04 and includes:

1. Electricity at $1.29 /sq foot
2. Heat at 1.47 /sq foot
3. Water at $ .28/sq foot

After the total square footage was determined and the annual cost was calculated, the number of patients using the space was determined and the total annual cost per patient for each space was determined.

For the Berwick Satellite Unit total operating costs were listed as $10.00/square foot/annum. This cost included accounting/administration, maintenance, office operation and utilities. An attempt to obtain any further degree of detail was

unsuccessful. It was decided that the costs obtained from the QE II HSC would be used for the Berwick Satellite as well.

Table 37 contains the yearly cost of overhead by unit. Each patient may use more than one area.

Table 37. Haemodialysis Utilities – 2000 Costs

Space	Feet^2	Annual Cost	Patients	Cost/patient/year
In-centre HD	7375.68	$22,442.07	198 *	$113.34
Home Unit	3261.05	$9,913.59	201 †	$49.32
Shared IC and HU	2496.35	$7,588.90	399‡	$19.02
Technical	1428.65	$4,343.10	198 §	$21.93
Berwick Satellite	990	$3,009.60	10 ‖	$300.96

* number is all In-centre dialysis patients.
† number is all patients that use the Home Unit; Peritoneal and Haemodialysis
‡ number is all dialysis patients
§ number is all In-centre haemodialysis patients.
‖ number is Berwick satellite patients

From the table above, a total cost per patient per year can be calculated.

An In-centre patient uses the In-centre HD unit, the shared area and the technical space, which equates to a cost of $154.29 per In-centre patient per year.

A Satellite patient from Berwick uses the Home unit space, the shared space and the satellite space, which equates to a cost of $369.30 per Berwick satellite unit

per year. If the Berwick satellite were at similar patient capacity as the In-centre unit the cost per patient would be $141.92.

3.2.5.2 Haemodialysis Overhead - House-keeping Costs

The annual cost for housekeeping was obtained form the QE II HSC Manager of Housekeeping and Contracts. The cost per square foot is $3.38 per annum. Using the same space measurements as for the utilities, the table 38 lists the cost for housekeeping.

Table 38. Haemodialysis Utilities- 2000 Housekeeping Costs

Space	Feet^2	Annual Cost	Patients	Cost/patient/year
In-centre HD	7375.68	$24,929.79	198 *	$125.91
Home Unit	3261.05	$11,022.35	201 †	$54.84
Shared IC and HU	2496.35	$8,437.66	399‡	$21.15
Technical	1428.65	$4,828.84	198 §	$24.39
Berwick Satellite	990.00	$3,346.20	10 ‖	$334.62

* number is all In-centre dialysis patients.
† number is all patients that use the Home Unit; Peritoneal and Haemodialysis
‡ number is all dialysis patients
§ number is all In-centre haemodialysis patients
‖ number is Berwick satellite patients

The cost for each In-centre patient would be In-centre HD, Technical and shared space. The total cost per In-centre patient per year was $171.45. The cost per year for a Satellite patient in Berwick was the sum of the Home Unit, the shared space and the Satellite Unit, which equalled $410.61.If the Berwick satellite was

at the same capacity as the In-centre unit, the cost per patient per year would be $168.94.

3.2.5.3 Haemodialysis Overhead - Accounting /Administration

In order to assign a cost of accounting and administration to each patient, the following was done. The portion of the entire QE II HSC budget that the haemodialysis budget occupied was determined. This portion would be the same portion of the accounting/finance budget.

Total QE II HSC Budget	$489,802,781.00
Total Haemodialysis Budget	$5,232,112.00 (1.068% of total budget)
QE II HSC Finance Budget	$4,992,390.00
1.068% of Finance Budget	$53,318.73

All patients in the dialysis program are managed for the most part through the QE II HSC. Therefore, the cost is divided among all 399 patients.

$53,318.73 divided by 399 patients equates to a cost of $133.63 per patient per year. If the satellite unit were at the same capacity as the In-centre unit the cost per year for all patients would decrease to $107.07.

3.2.6 Patient Travel Costs

In the satellite unit, the majority of patients travel to dialysis by themselves or with a family member (40 % of the In-centre and 68 % of the Satellite patients). If the satellite patients were required to travel to Halifax for haemodialysis the mean round trip distance would be 283 km (N= 34). Using the QE II HSC standard rate of reimbursement for travel of $0.315, this equates to an annual cost of travel of $13,923.85 (SD $4,134.06). Forty percent of the In-centre patients are transported to dialysis treatments by a private driver at a cost of $10.00 per round trip or $1,560.00 per year.

3.2.7 Yearly cost of In-centre and Satellite Haemodialysis

The yearly cost of In-centre and Satellite dialysis were calculated using the data collected. The results are presented in tables 39 to 47 with the cost displayed in four categories: Dialysis Staff, Nursing Staff, Capital Costs and Consumables, and Overhead. The percentage that each cost category contributed to the total cost was also calculated. Costs for Satellite dialysis were calculated for actual numbers as well as similar capacity as the In-centre unit.

The In-centre unit was operating at 89% capacity, and therefore the same capacity was determined for the satellite unit. Full capacity for the satellite unit was taken from table 7, with three shifts per day. The number of satellite patients would increase from 42 to 162 at 89% capacity. Fixed costs were recalculated for the increased capacity, as was outlined in the appropriate sections. Depending on the resource cost that was recalculated the patient numbers were

increased to 89% for the entire satellite program or only for the Berwick satellite unit.

3.2.7.1 Total costs per patient per year for Satellite Haemodialysis

Table 39. Satellite Unit Staff Costs

	Actual Cost/Year	89% Capacity Cost/Year
Nephrologist	$1882.44	$1882.44
Dietician	$15.92	$15.92
Social work	$30.61	$30.61
Nursing Manager	$480.28	$140.08 *
Admin Secretary	$78.83	$52.29 †
Unit Clerk	$224.45	$140.54 ‡
HD Nurse	$68.18	$23.47 §
Charge Nurse	$134.65	$134.65
Clinic Nurse	$55.07	$55.07
On Call Nurse	$248.76	$155.76 ‖
Sick Relief	$660.85	$660.85
Dialysis Assistant	$16,801.48	$8,400.74 ¶
Total Dialysis Staff Cost	$20,681.52	$ 11,692.42

* 144 patients as per 89% capacity

† 303 patients: 144 NS satellite, 21 PEI satellite and 138 PD

‡ 303 patients

§ 165 patients: 144 Nova Scotia satellite and 21 PEI satellite

‖ 303 patients

¶ staff to patient ratio of 1:2

Table 40. Satellite Unit Capital Costs and Consumables

	Actual Cost/Year	89% Capacity Cost/Year
Dialysis Supplies	$7,229.04	$7,229.04
Dialysis Machine	$2,266.33	$809.40 *
Machine Maintenance	$1,925.50	$ 687.68 *
Water Treatment	$1,868.45	$ 583.89 *
Routine Lab Tests	$1450.00	$ 1,450.00
Heparin	$192.29	$192.29
Eprex	$4,802.00	$4,802.00
IV Iron	$144.00	$144.00
Linen	$427.82	$427.82
Total Dialysis Consumables Cost	$20,305.43	$ 16,326.12

* Indicates fixed resources that were recalculated with capacity patient numbers.

Table 41. Satellite Unit Overhead Costs

	Actual Cost/Year	89% Capacity Cost/Year
Utilities	$369.30	$ 151.94 *
Housekeeping	$410.61	$168.94 *
Admin/Accounting	$ 133.63	$ 107.07 *
Total Cost	$913.54	$ 427.95

* Indicates fixed resources that were recalculated with capacity patient numbers.

Table 42. Summary of Satellite Haemodialysis Costs for 2000

Category	Actual Cost/Year	% Total Cost	89% Capacity Cost/Year	% Total Cost
Staff	$2,712.53	6.5	$2,348.10	8
Nursing	$17,968.99	43	$9,430.54	33
Capital and Consumables	$20,305.43	48	$ 16,326.12	57
Overhead	$913.54	2	$ 427.95	1.5
Total Cost	**$41,900.49**	**100**	**$28,446.49**	**100**

Total cost of a year of Satellite Haemodialysis is $41,900.49 per patient. The cost per year would decrease to $28,446.49 if the satellite patient numbers were at the same capacity as In-centre. The actual percentages that each category contributes to the total cost are shown in table 42.

3.2.7.2 Total costs per patient per year In-centre Haemodialysis

Table 43. In-centre Haemodialysis Staff Costs

	Cost/Patient/Year
Nephrologist	$10,319.40
ERN	$730.51
Dietician	$72.85
Social work	$55.10
Nursing Manager	$293.48
Admin Secretary	$82.39
Unit Clerk	$414.71
Total Cost	$11,968.44

Table 44. In-centre Haemodialysis Nursing Costs

	Cost/Patient/Year
Registered Nurse	$13,658.17
LPN	$1,032.82
Renal Assistant	$1,906.12
Ward Aide	$370.94
Total Nursing Cost	$16,968.05.

Table 45. In-centre Haemodialysis Capital Costs and Consumables Costs

	Cost/patient/year
Dialysis Supplies	$5357.04
Dialysis Machine	$824.86
Machine Maintenance	$829.47
Water Treatment	$396.24
Routine Lab Tests	$1450.00
Heparin	$192.29
Eprex	$4575.00
IV Iron	$499.00
Linen	$427.82
Total Dialysis Capital costs and Consumables	$14,551.72

Table 46. In-centre Haemodialysis Overhead Costs

	Cost/patient/year
Utilities	$154.29
Housekeeping	$171.45
Admin/Accounting	$133.63
Total Cost	$459.37

Table 47. Summary of In-centre Haemodialysis Costs

Category	Cost/patient/year	% Total Cost
Staff	$11,968.44	27
Nursing	$16,968.05	39
Capital and Consumables	$14,551.72	33
Overhead	$451.27	1
Total Cost	**$43,939.48**	100

The cost per patient for a year of In-centre dialysis treatment is $43,939.48 with the haemodialysis unit at 89% capacity. Areas of potential cost saving will be explored in the sensitivity analysis.

3.2.8 Comparison of In-centre with satellite Costs

In tables 48 to 52, the costs of In-centre haemodialysis will be compared to satellite by first looking at the total cost and then differences within each of the cost categories.

Table 48. Comparison of In-centre and Satellite Total costs

	In-centre Unit		Satellite Unit			
	89% Capacity		Actual Cost		89% Capacity	
Category	Cost/ Patient/ Year	% Total Cost	Cost/ Patient/ Year	% Total Cost	Cost/ Patient/ Year	% Total Cost
Staff	$11,968.44	27	$2,712.53	6.5	$2,348.10	8
Nursing	$16,968.05	39	$17,968.99	43	$9,430.54	33
Capital and Consumables	$14,551.72	33	$20,305.43	48.5	$ 16,326.12	57
Overhead	$451.27	1	$913.54	2	$ 427.95	1.5
Total	**$43,939.48**	**100**	**$41,900.49**	**100**	**$28,446.49**	**100**

As table 48 shows, there are differences between the In-centre and Satellite Units total costs. The cost of satellite unit maintenance haemodialysis is only 4.6 % less than In-centre if actual satellite patient numbers are used. Increasing the Satellite patient numbers to similar capacity as the In-centre unit results in a 32% decrease in the yearly cost of maintenance haemodialysis. This decrease of $13,454.00 per patient is the result of an almost 50% decrease in nursing and overhead costs and a 20% decrease in capital and consumable costs.

Staff costs are considerably higher in the In-centre unit as compared to the Satellite Unit. As shown in table 49, the reason for this is the higher physician reimbursement for care of the In-centre patient. The cost of the extended role nurses also contributes to the In-centre staff cost. Dietitian costs were higher in the In-centre unit as a result of personnel contact with the patients rather than telephone contact with the Satellite patients. Unit clerk costs were also twice as much for the In-centre unit. Increasing the number of patients in the satellite unit results in lower staff costs for only the Nursing manager, administrative secretary and unit clerk.

Table 49. Comparison of In-centre and Satellite Unit Staff Costs

	In-centre	Satellite	
	Actual Yearly Patient Cost	Actual Yearly Patient Cost	89% Capacity Yearly Patient Cost
Nephrologist	$10,319.40	$1882.44	$1882.44
ERN	$730.51	N/A *	N/A *
Dietician	$72.85	$15.92	$15.92
Social work	$55.10	$30.61	$30.61
Nursing Manager	$293.48	$480.28	$140.08
Admin Secretary	$82.39	$78.83	$52.29
Unit Clerk	$414.71	$224.45	$140.54
Total	**$11,968.44**	**$2,712.53**	**$2,261.88**

* N/A = not applicable

Comparing the nursing costs of the In-centre unit to the satellite unit is not as straightforward as the nursing structure of the two units is different. For the

satellite unit, the Dialysis Assistant is responsible for the majority of patient care, with additional assistance from the Home Unit. The staffing of the In-centre unit involves a mix of various levels of nursing training. The registered nurse in the In-centre unit, and the dialysis assistant in the satellite account for the majority of nursing cost.

Each satellite unit patient requires a certain amount of nursing care that is provided by the Home unit. This amounts to $368.95 per patient per year. As shown in table 50, nursing costs can decrease with increasing patient numbers in the satellite unit, as this enables a cost saving staff to patient ratio.

Table 50. Comparison of In-centre and Satellite Unit Nursing Costs

In-centre		Satellite		
Category	**Actual Cost/Patient/ Year**	**Category**	**Actual Cost/ Patient /Year**	**89% Capacity Cost/ Patient/ Year**
Registered Nurse	$13,658.17	HD Nurse	$68.18	$23.47
Licensed Practical Nurse	$1,032.82	Charge Nurse	$134.65	$134.65
Renal Assistant	$1,906.12	Clinic Nurse	$55.07	$55.07
Ward Aide	$370.94	On Call Nurse	$248.76	$155.76
		Sick Relief	$660.85	$660.85
		Dialysis Assistant	$16,801.48	$8,400.74
Total Nursing Cost	**$16,968.05**	**Total Nursing Cost**	**$17,968.99**	**$9,430.54**

Table 51 below compares the costs of capital equipment and consumables between the In-centre and satellite units. Some of the costs items such as Eprex and IV iron were collected on a per patient basis. Other items such as heparin and laboratory tests are exactly the same for both the In-centre and satellite patients. Capital cost items are subject to change as a result of patient numbers. The difference in cost of the dialysis supplies between the two units is solely due to the cost difference of the dialyzer. Reuse of dialysers is not possible in the satellite haemodialysis program.

Table 51. Comparison of In-centre and Satellite Unit Consumables Costs

	In-centre	Satellite	
	Cost/Patient/Year	Actual Cost/Patient/Year	89% Capacity Cost/Patient/Year
Dialysis Supplies	$5357.04	$7,229.04	$7,229.04
Dialysis Machine	$824.86	$2,266.33	$809.40
Machine Maintenance	$829.47	$1,925.50	$687.68
Water Treatment	$396.24	$1,868.45	$583.89
Routine Lab Tests	$1450.00	$1450.00	$1,450.00
Heparin	$192.29	$192.29	$192.29
Eprex	$4,574.00	$4,802.00	$4,802.00
IV Iron	$499.00	$144.00	$144.00
Linen	$427.82	$427.82	$427.82
Total Dialysis Consumables Cost	**$14,550.72**	**$21,319.44**	**$16,326.12**

Once again, increasing patient numbers in the satellite unit results in cost savings in the areas of dialysis machines and water treatment costs.

The final cost category to consider is that of overhead costs, which are compared in table 52. The cost of utilities and housekeeping decreases in the satellite unit with increasing patient numbers. All dialysis patients share the cost of administration equally, and therefore, the cost decreases for all patients as numbers increase.

Table 52. Comparison of In-centre and Satellite Unit Overhead Costs

	In-centre Unit	Satellite Unit	
	Cost/Patient/Year	Actual Cost/Patient/Year	89% Capacity Cost/Patient/Year
Utilities	$154.29	$369.30	$151.94
Housekeeping	$171.45	$ 410.61	$168.94
Admin/Accounting	$133.63 *	$133.63	$107.07
Total Overhead Cost	**$459.37**	**$913.54**	**$427.95**

* This amount would decrease to $107.07as all dialysis patients equally share this cost.

3.2.9 Sensitivity Analysis

Three areas were chosen for one-way sensitivity analysis; the cost consequence of increasing satellite patient numbers, the impact of increasing satellite patient numbers on nursing costs, and the impact on cost as a result of changing the In-centre nursing staff mix.

3.2.9.1 Sensitivity Analysis - Satellite Unit Costs

Table 53 below shows the effect of increasing patient numbers on certain costs in the satellite unit. For comparison, the In-centre cost is also provided.

Table 53. Satellite Unit Costs Sensitivity Analysis

Category	Total Cost	Cost/patient N = 10 *	Cost/Patient N = 24†	Cost/Patient N = 36 ‡	In-Centre Cost
Machine Capital Cost	$22,663.33	$2,266.33	$944.30	$629.54	$824.86
Machine Maintenance	$19,255.00	$1,925.50	$802.29	$534.86	$829.47
Water Treatment	$18,684.50	$1,868.45	$778.52	$519.01	$396.24
Utilities	$3,696.10	$369.61	$125.40	$83.60	$154.29
Housekeeping	$4,106.10	$410.61	$171.09	$114.06	$171.45

* Actual patient numbers in Berwick Satellite Unit

† Based on two shifts of six patients.

‡ Based on three shifts of six patients a day.

As shown in table 53 above, as satellite patient numbers increase costs decrease in several areas and become similar to the In-centre costs.

Nursing costs account for 39 % of In-centre costs and 43 % of satellite haemodialysis costs. It was also shown how increasing patient numbers in the satellite unit would allow a change in staff to patient ratio that would result in lower cost.

3.2.9.2 Sensitivity Analysis - Satellite Unit Nursing Staff

The following table shows how increasing patient numbers in a satellite unit allows for changes in staff to patient ratios which in turn impacts on cost.

Table 54. Satellite Unit Staffing Sensitivity Analysis

Patient Number	Patients per Shift	Staff to Patient Ratio	Cost per patient per Year
10	variable	1:1	$16,801.48
24- 36	6	2:3	$11,200.99
24-36	6	1:2	$8,400.74

As shown in the table 54 above, as the number of patients per shift increases there is potential to change the staff to patient ratio. If the satellite unit has six dialysis machines, then having all the machines occupied with patients for two (24 patients) or three (36 patients) shifts results in cost savings.

3.2.9.3 Sensitivity Analysis - In-centre Dialysis Unit Nursing Staff

In the In-centre unit the registered nurse provides the majority of direct patient care. In recent years other staff have assumed some aspects of patient care responsibility. Table 55 shows how the nursing staff -mix in the In-centre unit could be changed to reduce costs. The data on patient nursing requirements was taken from the GRASP data. The mean amount of nursing time required by an In-centre patient was 2.83 hours. Four scenarios were considered, assuming a Registered nurse (RN) to patient ratio in the In-centre unit of 1:2, all care

provided by an RN, more RN than Dialysis Assistant (DA) care, more DA than RN care and all DA care. The salaries are taken from the salary scales in Appendix D. For each scenario a cost per treatment and a cost per treatment year was calculated.

Table 55. In-centre Nursing Staff Sensitivity Analysis

Scenario	Staff *	Time †	Cost/Hour	Cost/Run	Cost/Year	Total Cost/Year
1.	RN	1.5	$26.59	$39.89	$6,222.84	$6,222.84
2.	RN	1	$26.59	$26.59	$4,148.04	
	DA	.5	$18.46	$9.23	$1,439.88	$5,587.92
3.	RN	.5	$26.59	$13.30	$2,074.80	
	DA	1	$18.46	$18.46	$2,879.76	$4,954.56
4.	DA	1.5	$18.46	$27.69	$4,319.64	$4,319.64

* RN is registered nurse and DA is dialysis assistant.
† Time in hours.

As shown above, by increasing the patient care done by staff with lower salaries, there is the potential to reduce the cost of nursing resources in the In-centre unit. A further model could be created that allowed for part of the patient care time to be done by Unit aides, which would further decrease costs.

Chapter 4

Discussion

In summary, 61 of 152 total care In-centre patients were compared to 38 of 42 Nova Scotia Satellite Patients. After the initial selection of the In-centre patients reclassification revealed that only 37 of the 61 were comparable to the satellite patients on the basis of vascular access and medical stability. In fact, only 37 of 131 total care (in-centre) haemodialysis patients were considered to be satellite candidates. This underscores the clinical complexity of the dialysis patients, where both medical stability and vascular access status can change within a short period of time.

When the satellite patients were compared to the In-centre patients they were found to be younger, on dialysis for a longer period of time, and have less co morbid medical conditions. The aetiology of renal failure was different in the two groups, with diabetes and hypertension being the most common reason for ESRD in the In-centre patients as compared to glomerulonephritis and other renal diseases in the satellite patients. The difference in the mean ages was 10 years, while the difference in the duration of haemodialysis was 7 months. There were also more men than women on dialysis in the satellite unit.

The differences between the In-centre and satellite patients did not change when the satellite patients were compared to the original 61 In-centre patients or to only the 37 patients with AVFs who were medically stable.

In order to determine if the study patients were similar to other Canadian haemodialysis patients, data was obtained from the Canadian Organ Replacement Registry (CORR) [3] . CORR collects data on all incident and prevalent dialysis and transplant patients in Canada. The 2000 report [3], included information on the 1998 incident and prevalent dialysis patients, with data on provincial and total Canadian patients.

The average age of the new patients (including paediatric patients) was 60 in 1998. The 1998 incident patients would be comparable to the study patients who had been on dialysis an average of 32 to 37 months at the time of data collection. The mean age of the incident haemodialysis patients in 1998 was 65 for Nova Scotia/PEI patients and 60 for all Canadian patients. The mean age of all the study patients was 66.

The study patients were also compared to the 1998 incident Canadian dialysis patients to determine if the aetiology of renal failure and co morbidities were similar. In table 56, the aetiology of renal failure in the study patients is compared to that of the 4,024 new patients in 1998.

Table 56. Comparison of Aetiology of ESRD

		1998 Incident Patients *	
Primary Renal Disease	**Study Patients N = 99**	**Canadian N = 4024**	**Nova Scotia N= 139**
Diabetes	23%	30%	31%
Hypertension	25%	20%	26%
GN †	22%	16%	15%
PCKD ‡	5%	4%	4%
Other	21%	11%	15%
Unknown	3%	14%	3%

* Data from 2000 CORR Report [3]
† GN = glomerulonephritis
‡ PCKD = Polycystic Kidney Disease

Table 56 shows that the study patients were similar to new patients in Nova Scotia and Canada with respect of aetiology of renal failure.

The study patients were also compared to the 1998 Incident Canadian haemodialysis patients with respect to co-morbid conditions in table 57.

Table 57, Comparison of Co morbidities

Co-morbidity	Study Patients N = 99	1998 Incident Patients N = 4024 *
Hypertension	71%	81 %
Cardiovascular disease	41 %	48 %
Diabetes	27 %	40 %
Stroke	6 %	11 %
Peripheral Vascular Disease	17 %	18 %
Amputation	4 %	N/A †

* Canadian 1998 Incident patients, which include patients < 18 [3] .
† N/A = not available

Once again, from table 57, the study patients were similar to the 1998 incident Canadian patients. Hypertension and diabetes was less common in the study patients. Unfortunately, the CORR data is not broken down by type of dialysis unit the patient receives treatment in. It is therefore not possible to compare the study patients by dialysis unit type.

The Canadian studies were reviewed to determine if the patients were similar to the study patients. Of the seven studies done on adult patients, only two [44;47] contained a limited amount of patient data, and only one included information about age, and aetiology of renal failure [47] .

The study patients as a group are similar to Canadian dialysis patients. The reasons for why the satellite patients in the study differ from the In-centre patients remain speculative. The patients that request satellite haemodialysis

are those that live enough of a distance away from the main In-centre unit that travel is difficult. If receiving dialysis treatment in a satellite unit is contingent on having a well functioning AVF and being medically stable, this would tend to select out a healthier group of satellite dialysis patients. Patients with diabetes and hypertension also have more medical problems than those with glomerulonephritis and other renal diseases. As well, individuals with glomerulonephritis and other renal diseases such as congenital renal diseases reach end stage renal disease at an earlier age, than patients with type 2 diabetes or hypertension.

All patients with renal failure that are on haemodialysis start treatment in the In-centre unit, and, if stable can move to a satellite unit. It may be that some patients may move to the city at the start of haemodialysis and not return to a rural community. Another possibility is that the more stable patients that live within a reasonable distance to the In-centre unit receive their haemodialysis treatment in the modified care In-centre unit. This results in the total care In-centre unit patients being either those who recently started dialysis or those having significant medical or dialysis access problems that they cannot receive treatment in any other unit.

Thus, in order to explain differences between these patient groups, more detailed data needs to be collected on these patients. This would need to include the place of residence at the time of diagnosis and after starting dialysis, detailed co morbidity data, employment data as well as socio-economic data.

In the end, it was thought unlikely that the differences in the patient groups would impact greatly on the costs of maintenance haemodialysis, and therefore regression analysis was not done to control for case-mix bias [65;66] . A previous study that used regression analysis also included hospitalization costs, which would have been influenced to a greater degree by age, renal disease, and co-morbidities of those patients [44] .

The primary purpose of the study was to determine if satellite haemodialysis was less expensive than In-centre dialysis. The first issue is to determine if all the important resources were considered, accurately collected and the costs calculated valid. From reviewing other studies and economic guidelines [44;45;50;56;67] resource items such as building depreciation, opportunity cost of the building and other capital costs were not collected. These items would have been difficult to collect accurately and were not expected to be different for comparing modalities with similar physical requirements. Food services and health records resources were not included, as they were not used by either of the programs. Radiology costs were also not included as no routine tests are done in the provision of maintenance haemodialysis.

No costs were determined for medical administration of the dialysis program. One nephrologist is the director of dialysis and provides medical administration of both the haemodialysis and peritoneal dialysis programs. However, there is no specific salary or remuneration attached to this position. Patient medications, other than those used directly for maintenance haemodialysis, were not considered. Some

medications that are necessary for renal replacement therapy, such as phosphate binders and vitamin D were therefore excluded.

A further exclusion was the additional cost of satellite patients receiving IV iron or Eprex. In the satellite unit the dialysis assistants are not able to give IV medications or subcutaneous Eprex injections. These patients receive IV iron in the medical day unit or emergency room of the local hospital or receive intramuscular iron. This in part explains why the cost of IV iron was lower in the satellite unit. Most satellite patients learn to administer their own Eprex, or have it administered to them by a home care nurse or family doctor. Exclusion of these resource items may lead to an underestimation of the total cost of satellite haemodialysis. However, some In-centre patients receive home care nursing visits on a regular basis, and therefore, the resource use may be equal.

The results show that the number of patients receiving treatment in a particular unit influences the cost of haemodialysis. The In-centre unit was at 89 % patient capacity, while the satellite dialysis program was at 26 % capacity and the Berwick or representative unit was at 28% patient capacity. The representative satellite haemodialysis unit had ten patients, and thus the cost per year for maintenance haemodialysis was a relatively conservative estimate. In units with fewer patients, the capital cost of the dialysis machine and water treatment system would be higher per patient, thus increasing the yearly cost.

From the Ministry of Health perspective, the cost of providing a patient with ESRD a year of maintenance In-centre haemodialysis in 2000 was $43.939.48. The major cost components of this were nursing 39 %, capital costs and consumables 33 %, staff, including physician fees 27 %, and overhead 1 %.

If the perspective of the Service provider is taken, then the physician fees are excluded and the cost per patient per year for in-centre haemodialysis decreases to $33,620.08. One-way sensitivity analysis of In-centre nursing costs revealed that increasing the amount of patient care given by non Registered nurse personnel would result in nursing costs decreasing by $634.92 to $1,903.20 per patient per year. If this were applied to the 198 patients receiving dialysis in the In-centre unit it would amount to a saving of $125,714.16 to $376,833.60 in one year.

The cost of maintenance haemodialysis in a satellite unit was determined for both the actual patient numbers and at similar capacity to the In-centre unit. From the Ministry of health perspective the actual cost per patient for a year of maintenance haemodialysis in 2000 was $41,900.49. Capital costs and consumables accounted for 48 % of this cost, nursing for 43 % and staff for 6.5 %. Cost per patient per year of maintenance haemodialysis with the satellite unit at similar capacity to the In-centre unit was calculated to be $28.446.49. Capital costs and consumables accounted for 57% of the cost, nursing for 33 % and staff for 8%. Overhead costs decreased form 2 % to 1.5 %.

When the perspective of the Service provider was taken, and physician fees removed, the actual cost of satellite haemodialysis was $40,018.05 per patient per year, and the calculated cost per year at 89 % capacity was $26,564.05.

One-way sensitivity analysis revealed that by increasing patient numbers in the satellite unit cost savings could be seen in nursing costs and certain fixed costs such as dialysis machines, water treatment and overhead costs. Table 58 displays the effect that perspective has on the yearly cost of haemodialysis.

Table 58. Effect of Economic Perspective on Cost

Economic Perspective	Haemodialysis Unit	Cost per patient per year
Ministry of Health	In-centre 89 % capacity	$43.939.48
	Satellite 28 % capacity	$41,900.49
	Satellite 89 % capacity	$28.446.49
Service Provider *	In-centre 89 % capacity	$33,620.08
QE II HSC	Satellite 28 % capacity	$40,018.05
	Satellite 89 % capacity	$26,564.05

* The service provider is the QE II HSC, which operates the provincial dialysis program.

As shown in table 58 above, the economic perspective impacts substantially on the cost. From both the Ministry of health and service provider perspective small satellite dialysis units with less than capacity patient numbers are associated with little or no cost saving.

The service provider planning delivery of dialysis to a region or province would see that In-centre dialysis is significantly less expensive than satellite dialysis, unless the satellite dialysis unit has enough patients to enable costs to decrease. As shown previously, cost savings accrue in the areas of nursing costs and capital equipment and consumables such as dialysis machines and water treatment. Total physician costs may not be dramatically different between the two units, as In-centre physician reimbursement compensates for more than just maintenance haemodialysis medical care. Local family doctors and medical specialists would see satellite haemodialysis patients, and this resource use and associated cost was not collected.

Before deciding on expanding satellite dialysis facilities several resource and cost factors need to be considered. The cost estimates made with increasing satellite units may not be accurate. Some of the presumed fixed variables such as dialysis machines and water treatment have a threshold capacity, beyond which more resources would be needed. Increased dialysis machine use and water requirements will most certainly increase maintenance costs. Considering certain staff positions as fixed resources is not completely accurate. Unit clerk time would tend to increase as satellite patient numbers increase. This study shows that support nursing and clerical staff are required at the main dialysis unit, and there would no doubt be increased numbers of support staff needed if the satellite patient numbers increased.

The largest area of cost saving with increased patient numbers was in nursing costs. This was seen as a result of decreasing the staff to patient ratio. Although,

in theory this is quite successful, practically it may be difficult to do. Increasing the number of patients in a satellite unit may require only a few larger units are maintained. This would result in patients having to travel greater distances to receive treatment, which would negate one of the benefits of satellite haemodialysis. One way of increasing patient numbers in the satellite units is to allow less medically stable patients in the units. However, this would require a registered nurse be present in the unit.

Also, before deciding that expansion of the In-centre unit is the most cost conscious method of providing dialysis therapy the following patient factors need to be considered. First is quality of life, which was not measured in this study. Others have measured quality of life in both In-centre, home haemodialysis, and peritoneal dialysis patients and found similar results [35;68-71] . Most of these studies are cross sectional and not controlled [69-71] No studies have been done that compare the quality of life of In-centre to satellite patients. A study done in Kingston, Ontario revealed that patients that move from a full-care to self-care dialysis unit showed significant increases in certain domains of the Short Form 36 quality of life questionnaire [72] . These patients were being allowed to receive treatment in a haemodialysis unit closer to their place of residence. Intuitively, a patient who wishes to receive treatment in a satellite unit and does so should have a better quality of life than one who is denied the same option due to a medical or dialysis access problem. If, however, in the end the cost of satellite haemodialysis is similar or lower than In-centre haemodialysis and the QOL of satellite patients is

at least similar to In-centre patients then satellite haemodialysis would dominate In-centre haemodialysis [57;73].

A second issue, which impacts on quality of life, is what additional cost would be borne by a satellite haemodialysis patient whom is changed to In-centre haemodialysis. The travel costs that the satellite patients may incur was found to be on average $13,923.85 per year, or on average $12,363.85 more than a local In-centre patient. Including travel costs in the evaluation expands the perspective to societal, but the impact of this additional cost to a patient population who are elderly and or have a low yearly income cannot be ignored when planning provincial dialysis services. Time and expense of travel is one of the main reasons patients chose satellite haemodialysis or its competitor, peritoneal dialysis.

To explore the impact of travel costs further table 59 shows the cost consequences of changing a satellite patient back to the In-centre unit.

Table 59. Effect of Change from Satellite to In-centre Haemodialysis

Economic Perspective	Haemodialysis Unit	Cost per patient per year
Ministry of Health	In-centre	$43.939.48
Societal *	In-centre local	$45,499.48
	In-centre rural	$57,863.33
	Satellite 28 % capacity	$43,460.49 †

* Societal includes the calculated travel costs only. In-centre local is the cost for a patient that lives within the city. In-centre rural is a patient who travels from a rural community to receive dialysis in the In-centre unit.

† A yearly cost of $1560.00, similar to the In-centre patient cost was added.

As shown in table 59, the societal cost of a patient receiving treatment in a satellite unit in 2000 was $43,460.49. If that patient were changed to In-centre dialysis the cost would increase to $57,863.33. Once again, the perspective used impacts on the final cost.

The results of this study were compared to other studies previously done. A review of the studies done in the USA revealed that the costs were expressed in US dollars in years 1983 to 1990 with costs for a year of dialysis ranging from $23,334.00 to $61,250.00 per treatment year [4;7;13;23;24;26;26;27;29;31-33;74]. Most of the studies did not contain enough detail for comparison, and most use Medicare reimbursement data, which only accounts for about 75 -80 % of the total cost [31;32].

The European studies reviewed also had wide variation in costs [4;34-38;75] with some final costs converted to US dollars. Most of the studies do not describe their methods in detail and how costs were converted to US dollars is not stated, which raises concerns regarding validity [50;56]. In response to the paucity of economic data on haemodialysis in Europe, a multi-centre study is currently underway to explore the costs and consequences of dialysis modalities [76]. Several other studies from other countries contained data on In-centre and home haemodialysis, but all costs were earlier than 1990 [39-41].

The Canadian study done by Churchill, et al in 1980 compared In-centre haemodialysis to Peritoneal dialysis [45]. The cost per year of haemodialysis in

1980 dollars was $40,500.00, of which $6,700.00 was physician fees. Four Canadian studies had costs of In-centre haemodialysis, self-care haemodialysis and peritoneal dialysis [11;12;43;44] . The study done in Montreal [43] had a reuse program, similar to the In-centre program in Halifax. The cost for In-centre haemodialysis for a year in 1988 dollars was $29,000.00, while self-care haemodialysis was $27,000.00 to 28,000.00. The cost of Eprex was not included. The study done by Baxter Canada [12] used salary and consumable costs in Ontario. The calculated costs in 1992 dollars were $42,197.00 for in-centre haemodialysis and $30,172.00 for self-care dialysis. Physician fees were not included in these costs.

A study comparing the costs and quality of life of a cohort of patients followed from dialysis to renal transplantation has also been done [47] . The average cost of dialysis in 1994 Canadian dollars was $42,748.00, however, it is unclear if all the patients were receiving haemodialysis, and if so, in what type of unit. The study done by the BC Renal Council determined that the yearly cost for In-centre haemodialysis was $49,881.00 as compared to $42,312.00 for limited care haemodialysis [11] . The costs are in 1994 dollars, but only limited information on this study is published [10] . A final study to consider was done by Goeree, et al in Hamilton [44] . Costs were determined in 1993 dollars. In-centre haemodialysis cost $69,412.00 per year, while self-care haemodialysis cost $48,515.00 per year. When comparing to the current study, the cost components of salaries and wages, supplies, Eprex and physician costs were similar. Overhead and support costs

were considerable higher for both In-centre and self-care haemodialysis in Hamilton as compared to Halifax. This is due to the overhead costs in the Hamilton study including building depreciation and opportunity costs [44] .

The Canadian study done to evaluate the costs of paediatric dialysis calculated the cost of maintenance haemodialysis to be $71,634.28 per patient per year in 1994 dollars [42] . There is no detailed breakdown of the costs that would allow comparison, however direct level treatment costs were $49,005.95 and overhead costs were considerably higher at $22,628.33.

Thus, in comparing the present study to others in the literature previous studies done in Canada are the most useful comparators. Interestingly, the costs calculated in 2000 are not much different than those calculated by Churchill, et in 1980 [45]. Similar costs were determined in British Columbia in 1994 [11] and Ontario in 1992 [12]. Many of the costs determined in this study are similar to those of the study done in Hamilton [44], except for overhead and support. The costs determined in this study would be lower than all the other Canadian cost calculations if the results were adjusted for inflation. Previous studies used various methods of allocating overhead, and also included building depreciation and opportunity costs, as well hospitalisations costs with additional allocated overhead [44;45] .

The secondary purpose of the study was to determine which costs make up the total cost of each modality, and determine if any would be amenable to changing

to decrease cost. For the In-centre unit, the nursing cost accounts for 39 % of the total cost. Most of this is registered nursing (RN) cost. There has been an attempt in the In-centre unit to introduce a staffing mix that corresponds to the needs of the patients and yet have non-nursing duties done by staff other than RNs. In a time when nursing shortages are becoming increasingly common, especially in areas such as dialysis and critical care, it is becoming increasingly important to use RN's for strictly nursing duties.

The sensitivity analysis revealed that by increasing the amount of patient care done by non-registered nursing personnel the cost per patient per year could be decrease by $634.92 to $1,903.20. This equates to a savings of $125,714.16 to $376,833.60 per year if applied to all 198 In-centre patients. The sensitivity analysis only examined RN's and LPN's, and further cost savings may be realized if additional lower cost per hour staff were included in the staff mix. For example, the Ward Aide or Renal Assistant could be given more responsibility for preparing the dialysis machines, thereby freeing up an LPN or RN for direct patient care. However, as time is reassigned the reality of part time and full time hours must be considered. Although having an extra unit aide for two hours at the end of each dialysis shift to prepare dialysis machines may be cost effective, it is not practical from a staffing perspective and certainly not desirable from an employee point of view. Another note of caution in planning staff mix is that the age and number of co-morbid medical conditions of new haemodialysis patients has been increasing [3] . Therefore, decreasing RN staff in the unit may not be possible or desirable as patient acuity.

Reduction in other staff in the In-centre unit is not possible. Of particular note is that of Dietitian and Social Work staff in both the In-centre and Satellite unit. In both of these areas, the staff to patient ratios falls below current national recommendations of one dietitian for every 100 to 150 dialysis patients [77;78]. Currently, one dietitian is responsible for 198 In-centre dialysis patients and 12 to 15 in-hospital nephrology patients. A second dietitian is responsible for the 201 Home unit patients and a similar number of renal transplant patients. The same is true of Social Worker numbers. A recent report prepared by the British Columbia Social Workers suggested that staffing guidelines for renal social workers should be one for every 75 – 100 dialysis patients [79].

In summary, the cost of maintenance haemodialysis was determined for two different treatment delivery settings, one in a hospital or In-centre unit and the second in a non-hospital or satellite unit. The number of patients receiving treatment in the unit in relation to the patient capacity of the unit influenced the total costs calculated. Thus, the answer to the primary objective of the study is that from the service provider and health institution perspective satellite haemodialysis is cost minimizing as compared to In-centre haemodialysis only if satellite patient numbers are at least 35 to 40 % of unit patient capacity. Achieving these patient numbers in satellite units may not be possible in areas with low population density and large geographical area. However, modifying existing in-centre units by

grouping together healthier patients and using more non-RN nursing staff would also be a way to decrease the overall cost of haemodialysis within the province.

The perspective of the study also influenced the total yearly costs, and patient concerns related to travel and other costs will need to be considered. However, financial implications of opening up new satellite units for only a few patients as compared to increasing patient numbers in existing units should be carefully considered.

This study was able to identify that nursing resources, which contribute a substantial amount to both In-centre and satellite costs may be amenable to cost minimizing change. The results of the study will serve as a useful resource for yearly budget planning as well as provincial dialysis program modification or expansion. This study will also serve as a background from which to evaluate more recent developments in delivery of dialysis care, such as nocturnal and daily haemodialysis. Both of these haemodialysis modalities are options, along with peritoneal dialysis, for the younger, healthier patients, who would be interested in receiving renal replacement therapy in a setting other than an In-centre haemodialysis unit.

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Appendices

Appendix A	**Medline Search Strategy**
Appendix B	**Satellite Haemodialysis Patient Criteria**
Appendix C	**Home Unit Charge Nurse Patient Log Sheet**
Appendix D	**QE II HSC Staff Salaries**
Appendix E	**Capital Cost Calculations**

APPENDIX A

Medline Search Strategy

SET	SEARCH
1	**Renal replacement therapy/**
2	exp Hemodialysis/
3	exp Hemofiltration/
4	Kidney, artificial/
5	exp Peritoneal dialysis/
6	exp Ultrafiltration/
7	Dialysis/
8	Kidney failure/or Kidney failure, acute/or Kidney failure, chronic/
9	Uremia/
10	(hemodia$ or haemodia$ or hemofilt$ or haemofilt$ or diafilt$.mp.[mp=title, abstract, registry number word, mesh subject heading]
11	(ultrafilt$ or dialy$ or biofilt$).mp.[mp=title, abstract, registry number work, mesh subject heading]
12	((kidney$ or renal) adj (disease$ or failure$ or sufficien$ or insufficient$)).mp.[mp=title, abstract, registry number work, mesh subject heading]
13	esrd.mp.[mp=title, abstract, registry number work, mesh subject heading]
14	ur?mi$.mp.[mp=title,abstract,registry number word,mesh subject heading]
15	1 or 2 or 3 or 4 or 5 or 6 or 10 or 11
16	8 or 9 or 12 or 13 or 14
17	15 and 16
18	controlled clinical trial.pt.
20	Meta-analysis.pt.
21	Randomized controlled trials/
22	Random allocation/
23	Double-blind method/
24	Single-blind method/
25	clinical trial.pt.
26	exp Clinical trials/
27	(clin$ adj4 trial$).mp.[mp=title,abstract,registry number word, mesh subject heading]
28	((singl or doubl$ or trebl$ or tripl$) adj4 (blind$ or mask$)).mp.[mp=title,abstract,registry number word,mesh subject heading]
29	Placebos/
30	placebo$.mp.[mp=title,abstract,registry number word, mesh subject heading]
31	random$.mp[mp=title,abstract,registry number word, mesh subject heading]
32	Research design/
33	18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32
34	33 and 17
35	Exp "Costs and cost analysis"/
36	Economics/
37	exp Economics/
38	ec.fs.
39	(cost$ or econ$ or fiscal$ or financ$).mp.[mp=title,abstract,registry number work, mesh subject heading]
40	35 or 36 or 37 or 38 or 39
41	34 and 40
42	17 and 40

APPENDIX B

Criteria for Haemodialysis Satellite Clinic Program

1. All patients must be assessed by a nephrologist and deemed to be an appropriate candidate based on the doctor's assessment at the time of training. This can include, but is not limited to:

    a. Absence of frequent, severe, symptomatic hypotensive episodes

    b. Absence of the need for supplementary oxygen

    c. Absence of uncontrolled, unstable angina

    d. Absence of frequent episodes of uncontrolled pulmonary edema

2. Patients must have an arteriovenous fistula capable of maintaining adequate blood flows to ensure adequacy of dialysis.

3. There must be no family member capable of performing home dialysis.

4. The patient must attend follow-up clinics in the Home Dialysis Unit every three months and as necessary.

5. The patient must reside in Nova Scotia.

6. The patient must be assessed and felt to benefit from satellite haemodialysis from a quality of life perspective.

7. All patients will be assigned to the dialysis clinic nearest their residence

APPENDIX C

Home Dialysis Unit Charge Nurse Patient Log

DATE _____

INSTRUCTIONS

- This form tracks resource utilization in the Satellite haemodialysis unit
- Please fill in using the format of the example line below
- Amount of time includes time on the phone, looking up information and writing notes

- **Source** relates to origin of problem:
- 1 = call from patient
- 2 = call from GP or consultant in community
- 3 = call initiated by Home unit nurse
- 4 = call initiated by Nephrologist
- 5 = call from Satellite unit nurse or assistant

Write brief note in comment:
Dialysis-related
Access –related
Other

TIME (min)	PATIENT	SOURCE	COMMENT

Please start a new sheet

APPENDIX D

QE II HSC Staff Salaries

All salaries, in dollars per hour, were obtained from the QE II HSC financial offices. Benefits of 18%, as per current contracts were added on to the base salary scales for April 2000.

1. Nursing Salaries

Yearly hours are 1920

1.1 Extended Role Nursing Salary

Salary Scale	Hourly wage	Hr wage + 18%	Annual Salary
1	$25.5665	$30.1685	$58,828.52
2	$26.1109	$30.8109	$60,081.18
3	$26.7324	$31.5442	$61,511.25
4	$27.4309	$32.3684	$63,118.50
5	$28.2085	$33.2860	$64,907.76
6	$29.0129	$34.2352	$66,758.69

1.2 Administrative Nursing Staff

Salary Scale	Hourly wage	Hr wage + 18%	Annual Salary
1	$23.93	$28.2374	$55,062.93
2	$25.43	$30.0074	$58,514.43
3	$26.93	$31.7774	$61,965.93
4	$28.42	$33.5356	$65,394.42
5	$29.92	$35.3056	$68,845.92

1.3 Registered Nurse Salary

Salary Scale	Hourly wage	Hr wage + 18%	Annual Salary
1	$19.8885	$23.4684	$45,763.38
2	$20.4327	$24.1105	$47,015.48
3	$21.0540	$24.8437	$48,445.22
4	$21.7532	$25.6688	$50,054.16
5	$22.5361	$26.5926	$51,855.57
6	$23.3351	$27.5354	$53,694.03

1.4 Dialysis Assistant (Satellite unit) or

Licensed Practical Nurse (LPN in In-centre unit)

Salary Scale	Hourly wage	Hr wage + 18%	Annual Salary
1	$14.3596	$16.9443	$33,041.39
2	$14.8445	$17.5165	$34,157.18
3	$15.2122	$17.9503	$35,003.27
4	$15.6417	$18.4568	$35,990.76
5	$16.1324	$19.0362	$37,120.59

2. Dialysis Staff Salaries

2.1 Renal Assistant

Assists the RN in the care of the patient: prepares the dialysis machine for new patients and cleans after patients. The Renal Assistant may also porter patients to and from the dialysis unit, as well as maintaining inventory control and stocking of dialysis supplies.

Salary Scale	Hourly wage	Hr wage + 18%	Annual Salary
1	$14.3596	$16.9443	$33,041.39
2	$14.8445	$17.5165	$34,157.18
3	$15.2122	$17.9503	$35,003.09
4	$15.6417	$18.4568	$35,990.76
5	$16.1324	$19.0362	$37,120.59

2.2 Unit Aide

Job involves transport of patients, helping patients obtain weights before and after dialysis.

Salary Scale	Hourly wage	Hr wage + 18%	Annual Salary
1	11.3773	13.4252	26,179.14
2	11.5749	13.6584	26,633.88
3	11.7721	13.8910	27,087.45
4	11.9721	14.1271	27,547.85
5	12.1709	14.3617	28,005.32
6	12.4726	14.7177	28,699.52

2.3 Unit Clerk

Unit clerks are present in the In-centre unit to provide clerical and receptionist duties. Yearly hours are 1820.

Salary Scale	Hourly wage	Hr wage + 18%	Annual Salary
1	$13.0847	$15.4399	$30,107.81
2	$13.0903	$15.8006	$30,811.17
3	$13.6970	$16.1624	$31,516.68
4	$14.0052	$16.5261	$32,225.90
5	$14.3114	$16.8875	$32,930.63

2.4 Administrative Secretary

Salary Scale	Hourly wage	Hr wage + 18%	Annual Salary
1	$13.11	$15.4698	$30,166.11
2	$13.92	$16.4256	$32,029.92
3	$14.75	$17.4050	$33,939.75
4	$15.57	$18.3726	$35,826.57
5	$16.39	$19.3402	$37,713.39

3. Dialysis Technician Salary

Salary Scale	Hourly wage	Hr wage + 18%	Annual Salary
1	$23.49	$27.7182	$54,050.49
2	$24.29	$28.6622	$55,891.29
3	$25.07	$29.5826	$57,686.07
4	$25.88	$30.5384	$59,549.88

4. Dietitian 2B Salary

Salary Scale	Hourly Wage	Hourly Wage + 18%	Annual Salary
1	$21.3808	$25.23	$49,197.32
2	$22.2319	$26.23	$51,155.56
3	$23.0823	$27.23	$53,112.47
4	$24.0094	$28.33	$55,245.68
5	$24.9372	$29.43	$57,380.47
6	$25.9422	$30.61	$59,693.11

5. Health Care Social Worker Salary

Salary Scale	Hourly Wage	Hourly Wage + 18%	Annual Salary
1	$21.3808	$25.23	$49,197.32
2	$22.2319	$26.23	$51,155.56
3	$23.0823	$27.23	$53,112.47
4	$24.0094	$28.33	$55,245.68
5	$24.9372	$29.43	$57,380.47
6	$25.9422	$30.61	$59,693.11

APPENDIX E

Capital Cost Calculations

The Following yearly capitals cost calculations were done using the method suggested by Drummond [824].

1. Dialysis Machine Capital Costs

Cost of each dialysis machine is 25,000.

Life of each dialysis machine is 10 years or 40,000 hours, with no machine value at the end of the lifespan, except occasional parts that are salvaged to repair other machines

YEARLY CAPITAL COST OF DIALYSIS MACHINE

Category	1	2	3	4	5	6	7	8	9	10
Depreciation	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
Undepreciated value at start	25000	22500	20000	17500	15000	12500	10000	7500	5000	2500
Opportunity rate 5%										
Opportunity Cost	1000	900	800	700	600	500	400	300	200	100
Depreciation and Opportunity Cost	3500	3400	3300	3200	3100	3000	2900	2800	2700	2600
Annuity Factor (table1)	0.9615	0.9246	0.8890	0.8548	0.8219	0.7903	0.7599	0.7307	0.7026	0.6756
Present Value	3365.25	3143.64	2933.7	2735.36	2547.89	2370.9	2203.71	2045.96	1897.026	1756.56

NET PRESENT VALUE = 24,999.996

In this method, the initial capital outlay was annuitized over the useful life of the machine. From the net present value, an equivalent annual cost can be calculated that contains both depreciation and opportunity costs. This method is used, as operating costs are the same each year.

Equivalent Annual Cost (E) = Net Present Value/ EF10.4%

E = 24.999.996/ 7.7217 = 3237.6285.

2. Water Treatment Capital Costs

2.1 In-centre unit

Two systems are used to provide the total amount of water needed.

Culligan System Purchase price 65,000.00 with a life of 20 years

Biolab System Purchase price 95,536.00 with life of 20 yrs

Yearly Capital Cost of In-centre Dialysis Water Treatment

Year	Depreciation	Undepreciated value at start	Opportunity Cost	Depreciation and Opportunity Cost	AF	Present Value
1	$8026.80	$160536.00	$6421.44	$14448.24	0.9615	$13891.98
2	$8026.80	$152509.20	$6100.37	$14127.17	0.9246	$13061.81
3	$8026.80	$144482.40	$5779.30	$13806.10	0.8890	$12273.62
4	$8026.80	$136455.60	$5458.22	$13485.02	0.8548	$11526.99
5	$8026.80	$128428.80	$5137.15	$13163.95	0.8219	$10819.45
6	$8026.80	$120402.00	$4816.08	$12842.88	0.7903	$10149.73
7	$8026.80	$112375.20	$4495.01	$12521.81	0.7599	$9515.32
8	$8026.80	$104348.40	$4173.94	$12200.74	0.7307	$8915.08
9	$8026.80	$96321.60	$3852.86	$11879.66	0.7026	$8346.65
10	$8026.80	$88294.80	$3531.79	$11558.59	0.6756	$7808.98
11	$8026.80	$80268.00	$3210.72	$11237.52	0.6496	$7299.89
12	$8026.80	$72241.20	$2889.65	$10916.45	0.6246	$6818.41
13	$8026.80	$64214.40	$2568.58	$10595.38	0.6006	$6363.58
14	$8026.80	$56187.60	$2247.50	$10271.30	0.5775	$5931.68
15	$8026.80	$48160.80	$1926.43	$9953.23	0.5553	$5527.03
16	$8026.80	$40134.00	$1605.36	$9632.16	0.5339	$5142.61
17	$8026.80	$32107.20	$1284.29	$9311.09	0.5134	$4780.31
18	$8026.80	$24080.40	$963.22	$8990.02	0.4936	$4437.47
19	$8026.80	$16053.60	$642.14	$8668.94	0.4746	$4114.28
20	$8026.80	$8026.80	$321.07	$8347.87	0.4564	$3809.97

Net Present Value = 160,535.56

Equivalent Yearly Value = 160535.56/12.4622 = 12,881.82

2.2 Water Treatment in the Berwick Satellite Unit

In the Berwick satellite, a DI system was used for the majority of water from January to April, 2000. From April 2000 on a Biopure Reverse Osmosis system was used for the bulk of water used. The DI system is maintained as a back up system. Capital costs for both systems were divided over an estimated 20-year lifespan.

Yearly Capital Cost of Satellite Dialysis Water Treatment

Year	Depreciation	Undepreciated value at start	Opportunity Cost	Depreciation and Opportunity Cost	AF	Present Value
1	$ 1300	$ 26,000	$1040.00	$ 2340.00	0.9615	$ 2249.91
2	$ 1300	$ 24,700	$988.00	$ 2288.00	0.9246	$ 2115.48
3	$ 1300	$ 23,400	$936.00	$ 2236.00	0.8890	$ 1987.80
4	$ 1300	$ 22,100	$884.00	$ 2184.00	0.8548	$ 1866.88
5	$ 1300	$ 20,800	$832.00	$ 2132.00	0.8219	$ 1752.29
6	$ 1300	$ 19,500	$780.00	$ 2080.00	0.7903	$ 1643.82
7	$ 1300	$ 18,200	$728.00	$ 2028.00	0.7599	$ 1541.08
8	$ 1300	$ 16,900	$676.00	$1976.00	0.7307	$ 1443.86
9	$ 1300	$ 15,600	$624.00	$1924.00	0.7026	$ 1351.80
10	$ 1300	$ 14,300	$572.00	$1872.00	0.6756	$ 1264.72
11	$ 1300	$ 13,000	$520.00	$1820.00	0.6496	$ 1182.27
12	$ 1300	$ 11,700	$468.00	$1768.00	0.6246	$ 1104.29
13	$ 1300	$ 10,400	$416.00	$1716.00	0.6006	$ 1030.63
14	$ 1300	$ 9,100	$364.00	$1664.00	0.5775	$ 960.96
15	$ 1300	$ 7,800	$312.00	$1612.00	0.5553	$ 895.14
16	$ 1300	$ 6,500	$260.00	$1560.00	0.5339	$ 832.88
17	$ 1300	$ 5,200	$208.00	$1508.00	0.5134	$ 774.21
18	$ 1300	$ 3,900	$156.00	$1456.00	0.4936	$ 718.68
19	$ 1300	$ 2,600	$104.00	$1404.00	0.4746	$ 666.34
20	$ 1300	$ 1,300	$52.00	$1352.00	0.4564	$ 617.05

Net Present Value = 26,000.09

E = 26,000.09/ 12.4622 = 2086.31 per year.